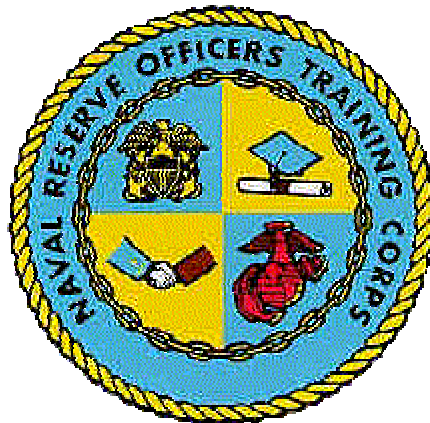


NAVAL RESERVE OFFICERS TRAINING CORPS

NAVIGATION



August 2005

NAVAL SERVICE TRAINING COMMAND

SF 080503

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

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NAVAL RESERVE OFFICERS TRAINING CORPS
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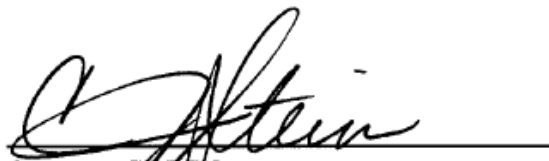
LETTER OF PROMULGATION

The Navigation Curriculum Guide is designed to be a primary resource to the instructor in preparing lesson plans. The curriculum guide was developed to encompass all of the Professional Core Competencies, which are designed to ensure a broad yet thorough education in basic surface ship navigation. Regardless of the extent to which lessons in this curriculum guide are implemented, or the number of credit hours offered by the host university for this course, it is the responsibility of the Professor of Naval Science to ensure that all Professional Core Competencies are adequately attained.

This curriculum guide also includes material that focuses on the moral and ethical responsibilities of military leaders, as well as the essential attributes of character required for effective leadership. While only two lessons deal specifically with these topics, instructors should include discussions of leadership in as many lectures as possible.

Instructors should promote critical thinking skills throughout this course of instruction and provide opportunities for students to demonstrate progression in both the cognitive and affective domains. Although this course focuses primarily on the cognitive and offers many opportunities for analysis, synthesis and evaluation, this curriculum can also be instructive in the affective domain as students practice valuing, organizing and internalizing aspects of Navy's culture and methods. Instructors are encouraged to use their own past experiences to illustrate and enrich their classroom instruction.

This course is approved for implementation upon receipt. Navigation I, CNET P1550/3 (08-01), is hereby canceled and superseded by this curriculum guide.



C. J. STEIN
NROTC Program Manager

22 August 2005
Date

DEFINITION OF MEASUREMENT TERMS

(Used in describing desired Professional Core Competencies
and supporting learning objectives)

- I. **Know** - Recall facts, bring to mind the appropriate material, recognize knowledge.

Examples: Know the objectives of damage control aboard ship.

Know the safety procedures used to provide the fullest measure of safe small boat operations.

- II. **Comprehend** - Interpret principles and concepts and relate them to new situations.

Examples: Comprehend the mission of the U.S. Navy and the U.S. Marine Corps.

Comprehend the concepts of internal forces (e.g., stress, strain, shear).

- III. **Apply** - Utilize knowledge and comprehension of specific facts in new relationships with other facts, theories, and principles.

Examples: Apply correct plotting procedures when navigating in piloting waters.

Apply correct procedures to determine times of sunrise and sunset.

- IV. **Demonstrate** - Show evidence of ability in performing a task.

Examples: Demonstrate third-class swimming skills and water survival skills.

Demonstrate the correct procedures used in radio-telephone communications.

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PROFESSIONAL COMPETENCY OBJECTIVES

The following professional core competency objective statements for this course are from the Professional Core Competency Manual for Officer Accession Programs promulgated in 2001.

1. The student will comprehend the moral and ethical responsibilities of the military leader.
 - a. The student will comprehend the leader's moral and ethical responsibilities to the organization and society.
 - b. The student will comprehend the relationship of integrity, moral courage and ethical behavior to authority, responsibility and accountability.
2. The student will know the fundamentals and limitations of space-based navigation and comprehend the operation of the global positioning system and the uses of precise positioning and time.
3. The student will comprehend the following personal qualities and be able to relate them to a leader's effectiveness:
 - a. Loyalty
 - b. Honor
 - c. Integrity
 - d. Courage (moral)
4. The student will know the theory and information that can be obtained from the practice of celestial navigation at sea.
 - a. The student will know the motions of celestial bodies and relate these motions to coordinate systems.
 - b. The student will comprehend the longitude/time relationship and time conversion, zone time

determination and motions of the sun as the basis of time.

- c. The student will know the correct procedures to determine the times of sunrise and sunset.
 - d. The student will know the use of computer-based celestial observation sight reduction and computer-based Nautical Almanacs.
5. The student will comprehend the theory and practice of marine navigation by GPS/NAVSSI and other electronic methods.
- a. The student will know the theory and basic principles of radar navigation.
 - b. The student will know the theory and basic operating principles of GPS/NAVSSI, including the importance of correcting for differences between the GPS/NAVSSI and navigation chart datum.
 - c. The student will know the basic principles of inertial navigation and bottom contour navigation.
6. The student will apply the fundamentals of the practice of marine navigation at sea.
- a. The student will comprehend the uses of navigational datums and various chart projections. The student will know chart symbology, particularly those symbols pertaining to hazards and dangers.
 - b. The student will know how to select the proper chart (both paper and electronic) and how to determine chart accuracy and reliability.
 - c. The student will apply correct plotting procedures when navigating in pilot waters.
 - (1) The student will apply the six rules of dead reckoning in keeping a plot of ship's movements.
 - (2) The student will comprehend the definitions of the terms: track, speed of advance, speed over ground, PIM, EP, LOP, relative bearing and course made good.

- (3) The student will know danger and turn bearings.
 - (4) The student will plot and interpret fixes and running fixes.
 - (5) The student will know the variables to compute the visibility of lights.
- d. The student will know the advantages, disadvantages, and applications of gyro and magnetic compasses.
 - (1) The student will apply terrestrial navigation methods to determine compass error.
 - (2) The student will apply magnetic variation and deviation or gyro error to convert from compass to true course or bearing and vice versa.
- e. The student will know the capabilities and limitations of various instruments used in piloting to determine direction, speed, distance, and depth of water.
- f. The student will know the essential publications and records used in navigation and comprehend their value in all applications.
- g. The student will know the characteristics and application of various aids to navigation in piloting and comprehend their importance in safe navigation, including:
 - (1) buoyage systems - IALA
 - (2) lights/daymarkers
 - (3) sound signals
 - (4) radar beacons/markers
- h. The student will apply correct procedures in planning and plotting approaches to harbors and anchorages.
- i. The student will comprehend tidal action and know tide classifications and reference planes.

7. The student will know the environmental weather factors affecting naval operations.
 - a. The student will know the basic principles of basic weather phenomenon, including fronts, subtropical and tropical storms.
 - b. The student will know the relationship between wind and current in wind-driven current systems.
 - c. The student will know the sources of environmental predictions, including pilot charts and weather broadcasts.
 - d. The student will know the earth's major wind and current systems.
 - e. The student will know how wind velocity relates to storm warnings and comprehend the effect of wind velocity on sea state.
 - f. The student will know the characteristics of the approach of tropical storms and hurricane/typhoon evasion techniques.
8. The student will know inland and international laws and systems of regulations which govern conduct of vessels in national waters and on the high seas.
 - a. The student will know the major aspects of the United States' position on International Law of the Sea regarding territorial seas, contiguous zones, high seas, and rights of innocent passage.
 - b. The student will know the U.S. Inland Rules of the Road and the international regulations for preventing collisions at sea to include:
 - (1) The purpose and scope of the rules, including application.
 - (2) Terms and definitions used in the rules.
 - (3) Steering rules for vessels in sight of each other, including sound signals.

- (4) Lights and day shapes for frequently encountered vessel classes.
 - (5) Use of radar and conduct of vessels in reduced visibility, including sound signals.
 - (6) Definition of situations falling under "special circumstances."
- c. The student will know the purpose and maneuvering rules associated with Traffic Separation schemes established by the International *[Intergovernmental]* Maritime Consultative Organization (IMCO) agreement. *[Note: The IMCO has evolved into the International Maritime Organization (IMO) and has amended the original IMCO agreement.]*
9. The student will comprehend relative motion and demonstrate capability to solve problems associated with relative motion.
- a. The student will comprehend the theory of relative motion as graphically displayed by the geographic and relative plot.
 - b. The student will comprehend the significance of bearing drift, apply bearing drift to determine relative motion, and comprehend the following related terms:
 - (1) Relative bearing
 - (2) Target angle.
 - c. The student will know the terminology and relationship of the speed triangle and the relative plot associated with the maneuvering board.
 - d. The student will demonstrate the use of the maneuvering board to accurately:
 - (1) Determine the CPA and time of CPA of an approaching vessel.
 - (2) Determine the course and speed of a maneuvering ship.

- (3) Determine course, speeds and time for proceeding to a new station or to intercept another vessel.
- (4) Determine true wind direction and velocity.
- (5) Determine course and speed to produce desired wind.

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LESSON #/TITLE		HOURS
<u>Section I: Marine Navigation</u>		
1	Introduction Plotting and the Piloting Team	1
2	Terrestrial Coordinate System/Chart Projections and Numbering	1
3	Navigational Publications and Chart Reading	1
	Laboratories One and Two	1
4	Visual Navigation Aids	1
	Laboratory Three	1
5	Navigation Instruments	1
6	Lines of Position (LOPs)/Fixes	1
7	Dead Reckoning	1
8	Running Fixes	1
	Laboratory Four	1
9	Magnetic Compass/Gyrocompass: Theory and Error	1
10	Tides, Tidal and Ocean Currents	1
11	Precise Piloting	1
12	Practical Piloting Exercise	.5
	Laboratory Five	1.5
<u>Section II: Introduction to Electronic Navigation</u>		
13	Celestial Theory	1
14	Electronic Navigation	1
15	Geodesy and Datums	1
16	Electronic Charts and ECDIS-N	1
17	Electronic and Radar Navigation	1
18	Weather	1
19	"The <i>USS Gonzalez</i> (DDG 66) Grounding" Case Study	2
<u>Section III: Laws of Vessel Operations/ Rules of the Road</u>		
20	Purpose and Scope of International and Inland Rules	1
21	International and Inland Lights and Dayshapes	3
22	Steering and Sailing Rules	3
<u>Section IV: Introduction to Relative Motion</u>		
23	Maneuvering Board Fundamentals	1
	Laboratory Six	1
24	Basic Tracking and Stationing	1
	Laboratory Seven	1
25	"Ramming of the Spanish Bulk Carrier <i>Urduliz</i> by the <i>USS Dwight D. Eisenhower</i> (CVN 69)" Case Study	2
Total Hours		37

**NAVAL RESERVE OFFICERS TRAINING CORPS
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INSTRUCTIONAL AIDS

I. Videos

- A. The following videos are part of the official curriculum and have previously been distributed to each unit:

<u>Number</u>	<u>Title</u>	<u>Running Time</u>
25484DN	Basic Celestial Concepts Theory	12 min.
23582DN	Rules of the Nautical Road - The Halifax Incident, 1942	7 min.
23588DN	Rules of the Nautical Road - City of Rome Incident, 1942	5 min.
23601DN	Rules of the Nautical Road - Svea/Newport Incident, 1943	5 min.
23605DN	Rules of the Nautical Road - Beaver/Selja Incident, 1943	5 min.
25488DN	Meteorology (Hurricanes), 1971	25 min.
34406DN	Melbourne/Evans Incident - I Relieve You Sir, 1975	35 min.

- B. The above videos should be controlled and serialized as part of the unit's standing educational materials to ensure they are available for future courses of instruction. It is the responsibility of the unit to keep track of the location of the videos and to maintain them in good working condition. Replacements for damaged videos may be ordered from the NETPDTC Regional Visual Information Center by contacting Mr. Ron Burk at ronald.burk@navy.mil or (850) 452-1001, ext 2020.
- C. Other videos may be obtained from university or community libraries, online vendors, online in public domain areas (without cost), or purchased by the unit through commercial vendors. (**NOTE:** When purchasing videos, units should consider the copyright laws that allow video usage for educational purposes/classroom use only.)

D. Instructors should be aware that commercial videos provided by NSTC or purchased by the unit are for use in an academic setting only. They are not to be reproduced, sold, copied, or shown in their entirety. Academic privileges allow instructors to utilize portions of videos, books, articles available to the public, and other media in academia to teach and educate. Using or distributing these videos in any fashion other than outlined here and in the lesson plans may constitute copyright infringements. Many short video clips from commercial movies provide the instructors contemporary, intriguing material to provide the students with examples of the ethical issues they are trying to teach. Use these segments appropriately. Seek official legal advice for any use not mentioned in this guide. Additional guidance may be found in SECNAVINST 5870.4.

E. Most universities have video libraries or audiovisual organizations that can provide current, topical films to units at no cost. These universities may also have additional funding or arrangements to purchase video rights and rental for use in the classroom environment. Consult with your university's film librarian to locate additional films to support lesson plans.

F. A wide variety of Department of Defense (DOD) materials are available through the Defense Automated Visual Information System/Defense Instructional Technology Information System (DAVIS/DITIS) website at: <http://dodimagery.afis.osd.mil>. This site contains listings and descriptions of thousands of audiovisual productions/videotapes and interactive multimedia instructional products used by DOD. The NETPDTC Norfolk Regional Electronic Media Center may also be able to provide desired multimedia resources, by contacting Mr. Ron Burk at ronald.burk@navy.mil or (850) 452-1001, ext. 2020.

II. Internet Resources. Note that all personnel must exercise caution in using material downloaded from the Internet. Access to works on the Internet does not automatically mean that these can be reproduced and reused without permission or royalty payment. Before using any materials downloaded from the Internet for use in training, you must determine what, if any, copyright restrictions might apply. A good rule of

thumb would be to presume that any information on the Internet is copyrighted, and that you should not use it without obtaining permission from the copyright holder. SECNAVINST 5870.4 provides specific guidelines that should be addressed in the copyright permission request letter.

III. Instructional Materials

A. Devices and Instruments

12" parallel ruler (NSN 6675-00-191-1507, COG S91, Unit of Issue SE), 1 per student
15" parallel ruler (optional), 1 per student
Navigator's Plotting Instrument Set (NSN 6675-00-286-0602), 1 per student
Rules of the Road Flash Cards, NAVEDTRA 10925 (3-5 per unit)
Nautical slide rule
Stadimeter (optional)
Alidade, Telescopic (optional)
Bearing circle (optional)
Sextant, Marine Horizontal (optional)
Chalk compass/dividers (18")
Large parallel rulers for chalkboard
Slate Globe, 1FF2B (optional)
Gyro Demonstrator, 1RR2 (optional)
Wall-mounted Maneuvering Board
Compass Trainer, 1DK2 (optional)
Celestial Navigation Sphere, 1A24
Position Plotting Sheets (NIMA REF NR WOBZP 5090)
Flashlight (optional)
Chalkboard/Whiteboard

B. Presentation Equipment

Videocassette player with monitor
PowerPoint slides with computer/projection system or overhead projector with instructor-prepared transparencies
Slide Projector
Projection Pad

NOTE: Obtain equipment not supplied by NSTC from university audiovisual sources.

C. Software

Computer Aided Software: NAVSIM (CAI0005R0389)
 Computer Aided Software: Rules of the Nautical Road
 (CAI0002R0289)
 Computer Aided Software: Rules of the Nautical Road,
 SOBT, Version 2.2.4, Jan 2005. (Download from
[http://www.navrules.com/.](http://www.navrules.com/))

D. Navigation Publications (Available from NIMA)

<u>Number</u>	<u>Title</u>
CATP2V01U	<u>DOD NIMA Catalog of Maps, Charts, and Related Products, Part 2, Vols. 1 & 2</u>
CATP2V01UBD	<u>DOD NIMA Catalog of Maps, Charts, and Related Products, Part 2, Semi-Annual Bulletin Digest</u>
SDPUB 130	<u>Planning Guide (Mediterranean)</u>
SDPUB 131	<u>Enroute Guide (Western Mediterranean)</u>
NVPUB 106	<u>Pilot Atlas of the North Atlantic Ocean, 1992</u>
NVPUB 150	<u>World Port Index</u>
NVPUB 151	<u>Distance Between World Ports</u>
FGPUB 940INTRO	<u>Atlantic Area Fleet Guides</u>
FGPUB 941INTRO	<u>Pacific Area Fleet Guides</u>
NOSPBCP 3	<u>Coast Pilot, Atlantic Coast Sandy Hook to Cape Henry (Available from NOS)</u>
COMDTM 165021	<u>Light List, Volume 1, Atlantic Coast, St. Croix River, Maine, to Toms River, New Jersey (1994)</u>
-----	<u>Notice to Mariners</u> (Available online)

E. NIMA Nautical and Reference Charts

<u>Number</u>	<u>Title</u>
---------------	--------------

WOBZC1	N.O. 1 - Nautical Chart Symbols
WOAZC17	Great Circle Sailing Chart - North Atlantic
WOXZC33	Horizontal Intensity, Earth's Magnetic Field
WOBZC42	Magnetic, Variation Epoch
WOBZC76	Standard Time Zone - Chart of the World
WOAGN120	North Atlantic Ocean (Southern Sheet)
WOBZPxxx	Various Position Plotting Sheets (920-936)
12AHA 12221	Chesapeake Bay Entrance
12AHA 12254	Cape Henry to Thimble Shoals Light
12AHA 12270	Eastern Bay & South River - Chesapeake Bay Entrance
BCXBC E0803	Bottom Contour Chart (N. coast of Colombia)

**NAVAL RESERVE OFFICERS TRAINING CORPS
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BIBLIOGRAPHY

A. **Texts** (1 per student, 1 per instructor)

Hobbs, R.R. Marine Navigation. 4th ed. Annapolis, MD: U.S. Naval Institute, 1998.

Hobbs, R.R. Marine Navigation Workbook. 4th ed. Annapolis, MD: U.S. Naval Institute, 1998.

Maneuvering Board Workbook, NAVPERS 93440-A. Bureau of Naval Personnel. (Consumable for student to keep.)

Naval Education and Training Command. Surface Ship Operations. NAVEDTRA 12973. Washington D.C.: GPO, 1994.

U.S. Department of Commerce. Tidal Current Tables 1984, Atlantic Coast of North America. Rockville, MD: National Ocean Survey, 1983.

U.S. Department of Commerce. Tide Tables, High and Low Water Predictions 1984, East Coast of North and South America Including Greenland. Rockville, MD: National Ocean Survey, 1983.

U.S. Department of Transportation. Navigation Rules International-Inland. COMDTINST M16672.2D. Washington, D.C.: GPO, 1999. (Also available at Coastguard Website, Rules of the Road, at:
<http://www.navcen.uscg.gov/mwv/navrules/navrules.htm>.)

U.S. Naval Observatory. The Nautical Almanac for the Year 1984, Washington, D.C.: GPO, 1982.

B. **Instructor References** (1 per instructor)

Allen, H. Craig. Farwell's Rules of the Nautical Road. 8th ed. Annapolis, MD: U.S. Naval Institute Press, 2005.

Brittin, B. H. International Law for Seagoing Officers. 5th ed. Annapolis, MD: U.S. Naval Institute Press, 1986.

COMNAVSURFLANT/COMNAVSURFPAC/COMNAVAIRPAC/COMNAVAIRLANT
Instruction 3530.4, Subj: Surface Ship Navigation
Department Organization and Regulations Manual.

Cutler, Thomas J. Dutton's Nautical Navigation. 15th ed.
Annapolis, MD: U.S. Naval Institute, 2004.

Hobbs, R.R. Marine Navigation Workbook Answer Key. 4th ed.
Annapolis, MD: U.S. Naval Institute, 1998.

Kotsch, W. J. Weather for the Mariner. 3rd ed. Annapolis, MD:
U.S. Naval Institute Press, 1983.

Lee, David M. CDR, et. al. Watch Officer's Guide. 14th ed.
Annapolis, MD: U.S. Naval Institute, 1999.

Shufeldt, H.H., Captain, USNR (Retired), and G.D. Dunlap.
Piloting and Dead Reckoning. 4th ed. Annapolis, MD: U.S.
Naval Institute, 1999.

U.S. Department of Defense. The American Practical Navigator
(Bowditch). Publication No. 9. Washington, D.C.:
National Imagery and Mapping Agency, 2002.

U.S. Department of Defense, Radar Navigation Manual and
Maneuvering Board Manual, Publication PUB 1310. Bethesda,
Maryland.: National Imagery and Mapping Agency, 2001.
Copied sections as needed per lesson.

USS San Francisco Underwater Collision Findings (Available at:
http://www.news.navy.mil/search/display.asp?story_id=18257)

United States Navy Regulations. Washington, D.C.: GPO, 1990.
(Available at: <http://neds.daps.dla.mil/regs.htm>.)

C. **Supplemental References** (Not provided by NSTC. To be used
as additional readings at the instructor's discretion.)

Naval Education and Training Command. Quartermaster. NAVEDTRA
82120, 1995.

Tate, William H. A Mariner's Guide to the Rules of the Road.
2nd ed. Annapolis, MD: U.S. Naval Institute Press, 1982.

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Where available, websites have been provided to assist instructors in accessing required and additional resources. Although these articles and materials are available via the World Wide Web, standard laws of copyright still exist. Instructors should use all materials in accordance with Fair Use Guidelines. (See cautions noted in the "Instructional Aids" section of this curriculum guide.)

**NAVAL RESERVE OFFICERS TRAINING CORPS
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LESSON GUIDE: 1

HOURS: 1

TITLE: Introduction Plotting and the Piloting Team

I. Learning Objectives

- A. The student will know the professional core competency objectives for the Navigation curriculum.
- B. The student will know the duties of the piloting team members.
- C. The student will know the navigation department's operational and administrative structures.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapters 1, 2, 3
- 2. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, Chapters 1, 2, 3
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Course syllabus (prepared by instructor)
- B. Chalkboard
- C. PowerPoint Slides

IV. Suggested Methods and Procedures

A. Method options

- 1. Informal introduction by instructor

2. Review of course syllabus (course content, grading, etc.)

3. Lecture

- B. Procedural and student activity options:
Distribute required course materials and publications.

V. Presentation

- A. Introduction of instructor

- B. Review the course syllabus and outline broad objectives of this curriculum as delineated on pages v-x.

- C. Discuss the members of the piloting team.

- D. Discuss the Ship's Navigation Department organization.

1. Administrative

2. Operational

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LESSON GUIDE: 2

HOURS: 1

**TITLE: Terrestrial Coordinate System/Chart Projections and
Numbering**

I. Learning Objectives

- A. The student will comprehend the terrestrial coordinate system.
- B. The student will comprehend the location of positions on earth using latitude and longitude.
- C. The student will comprehend the basic properties of the most commonly used chart projections.
- D. The student will know the chart numbering system.
- E. The student will comprehend the chart/publication correction system.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 4
- 2. American Practical Navigator, Bowditch, Chapters 3 and 5
- 3. Dutton's Nautical Navigation, Chapters 2, 3 and 5
- 4. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, Chapter 4
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Slate globe (recommended)

- B. PowerPoint Slides
 - C. Chart numbers 17 and 76 or substitutes
 - D. Notice to Mariners
 - E. Computer/projection system or overhead projector
 - F. Computer with projection system
- IV. Suggested Methods and Procedures
- A. Method options: Lecture/Demonstration
 - B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises
- V. Presentation
- A. Using the slate globe and/or transparencies, develop the terrestrial coordinate system by explaining:
 - 1. Spheroid versus sphere shape
 - 2. Axis and poles
 - 3. Great circles versus small circles
 - 4. The equator and the angular measures of latitude small circles
 - 5. Greenwich meridian and the angular measurement of longitude great circles
 - 6. Measurement of latitude along meridians; the contraction of the longitude scale
 - 7. Labeling of longitude and latitude
 - B. Discuss the desirable properties for any projection. Differentiate between a chart and a map.

- C. Using the map projection demonstrator, slate globe, and/or transparencies, illustrate plane, conic, and cylindrical projections; define and differentiate the various terms.
 - 1. Points of tangency
 - 2. Reference points of projection
- D. Using the world chart, discuss the characteristics of each projection, the inherent distortions, and the desirable properties.
 - 1. Conformal
 - 2. True shape
 - 3. Distortion of true size
 - 4. Rhumb lines versus great circles
 - 5. Measurement of distance and direction
- E. Discuss the characteristics of a gnomonic projection and contrast its appearance, use, and characteristics to a mercator projection.
- F. Discuss chart scale.
- G. Discuss chart numbering.
- H. Describe the chart correction system.
 - 1. Notice to Mariners, Local Notice to Mariners, and HYDROLANTS/HYDROPACS
 - 2. Use of chart correction card
 - 3. Use of NIMA's NAVINFONET
- I. Discuss the indicators of chart accuracy.
 - 1. Date of survey
 - 2. Completeness of soundings
 - 3. Chart scale

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LESSON GUIDE: 3

HOURS: 1

TITLE: Navigational Publications and Chart Reading

I. Learning Objectives

- A. The student will know how charts are catalogued in the National Imagery and Mapping Agency's (NIMA) Catalog of Maps, Charts, and Related Products and the National Ocean Service (NOS) Nautical Chart Catalogs.
- B. The student will know the contents of the reference publications Coast Pilots, Sailing Directions, Fleet Guides, Light List, List of Lights, Tide and Tidal Current Tables, and the other important texts and manuals used in navigation.
- C. The student will comprehend how publications are kept up-to-date.
- D. The student will know hazard and depth symbology used on charts.
- E. The student will apply basic plotting techniques using nautical charts.
- F. The student will comprehend the procedures for selecting the proper charts and how to determine chart accuracy and reliability.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 5
- 2. American Practical Navigator, Bowditch, Chapter 4
- 3. Dutton's Nautical Navigation, Chapters 3 and 5
- 4. Marine Navigation Workbook
- 5. *USS San Francisco Underwater Collision* (Available at:

http://www.news.navy.mil/search/display.asp?story_id=18257)

B. Student texts

1. Marine Navigation, Hobbs, Chapter 5, Appendix G
2. Marine Navigation Workbook

III. Instructional Aids

- A. Selected publications (Coast Pilot, Fleet Guides, Sailing Directions, Light List, etc.)
- B. Plotting instruments
- C. NIMA charts 120 and 12221 or substitutes
- D. Computer/projection system or overhead projector
- E. Pilot chart
- F. Laboratory 1 (Appendix A)
- G. Laboratory 2 (Appendix A)
- H. PowerPoint slides

IV. Suggested Methods and Procedures

- A. Method options
 1. Lecture
 2. Student inspection of navigation publications
- B. Procedural and student activity options
 1. Complete assigned reading
 2. Complete assigned workbook exercises

V. Presentation

- A. Using the NIMA Catalog and/or transparencies, demonstrate the means by which NIMA charts are

catalogued and how charts would be selected for entering a given harbor.

- B. Identify the various reference publications available to the navigator.
 - 1. Light List, List of Lights
 - 2. Coast Pilot, Sailing Directions, Fleet Guides
 - 3. Tide and Tidal Current Tables
 - 4. Pilot Chart
 - 5. Dutton, Bowditch, etc.
- C. Using chart number 12221 (or substitute) and Chart Number 1, Appendix G in Hobbs, have students identify various chart symbology -- stress hazards/dangers to navigation and depth/contour markings.
- D. Using chart 12221, have students plot lat/long positions, determine the lat/long coordinates of various navigational points of reference, and determine distance between two points.
- E. Have the student complete a practical exercise in identifying chart symbology. Labs 1 and 2 in Appendix A are provided as an aid to the instructor in fulfilling the requirement of this practical exercise.
- F. Discuss the importance of chart updating as determined in the investigation of the *USS San Francisco* collision with the underwater sea mount.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 4

HOURS: 1

TITLE: Visual Navigation Aids

I. Learning Objectives

- A. The student will comprehend the identifying characteristics and significance of lighted aids to navigation.
- B. The student will apply correct procedures to identify and determine the computed visibility of a navigational light.
- C. The student will be familiar with the shapes and lights of the International Association of Lighthouse Authorities (IALA) Combined Cardinal and Lateral System of buoyage.
- D. The student will comprehend the use of buoys and beacons during piloting.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 6
- 2. American Practical Navigator, Bowditch, Chapter 5
- 3. Dutton's Nautical Navigation, Chapter 6
- 4. Light List, Atlantic Coast
- 5. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, Chapter 6 and applicable sections of Appendix G (Chart No. 1)
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Light List Atlantic Coast, Vol. I, 1994
- B. Chart 12221 (or substitute)
- C. Chalkboard/whiteboard
- D. PowerPoint slides
- E. Flashlight (optional)
- F. Laboratory 3 (Appendix A)
- G. Computer with projection system

IV. Suggested Methods and Procedures

- A. Method options
 - 1. Lecture
 - 2. Practical exercise in computed visibility
- B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises

V. Presentation

- A. Discuss the physical and visual attributes of lighted aids to navigation and how these attributes are used to identify the purpose and location of each aid in a marine environment; particularly stress the characteristics commonly used to indicate proximate hazards to navigation or important navigation points.
- B. Define and delineate each distinguishing light phase characteristic using a flashlight and transparencies.
- C. Demonstrate the use of the Light List in identifying the characteristics of lighted aids to navigation.
 - 1. Phase

2. Period
 3. Sectors
 4. Alternating
 5. Lighted range
 6. Nominal range
 7. Physical characteristics
- D. Demonstrate the diagramming of the period of a lighted aid to navigation.
- E. Illustrate the determination of computed visibility and luminous range.
1. Geographic range = horizon distance of light + horizon distance of observer
 2. Luminous range = [enter luminous range diagram on p. 92 (Marine Navigation) with nominal range and existing meteorological visibility]
 3. Computed visibility
- F. Demonstrate the plotting of computed visibility.
- G. Discuss the purpose and general distinguishing features of the IALA Combined Cardinal and Lateral System of buoyage.
1. Distinguishing colors, shapes, sound signals, and light characteristics
 2. Relationship of shape and distinguishing characteristics with buoy placement and purpose
 3. Responsibility for buoyage system maintenance
 4. Use of buoys as objects for bearings in piloting
- H. Have the students utilize Chart Number 1, Appendix G in Hobbs, to relate the symbology on Chart 12221 to the U.S. Lateral System.

- I. Have the students complete a practical exercise in computing the visibility of a navigational light.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 5

HOURS: 1

TITLE: Navigation Instruments

I. Learning Objectives

- A. The student will comprehend the use of the azimuth circle, the bearing circle, and the alidade in the measurement of direction.
- B. The student will comprehend the use of the stadimeter in the measurement of distance.
- C. The student will comprehend the methods by which speed through the water is determined on a ship or boat.
- D. The student will comprehend the use of hand lead lines and echo sounders to determine depth.
- E. The student will know basic plotting instruments and apply correct procedures in their use.
- F. The student will apply correct procedures in the use of log scales and the nautical slide rule to determine speed, time, and distance given any two of the quantities.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 7
- 2. American Practical Navigator, Bowditch, Chapter 6
- 3. Dutton's Nautical Navigation, Chapters 7 & 8
- 4. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, Chapter 7
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Optional navigation instruments (alidade, bearing circle, stadimeter, sextant)
- B. Nautical slide rule
- C. Position plotting sheet (PPS) and dividers for each student
- D. PowerPoint slides
- E. Computer with projection system

IV. Suggested Methods and Procedures

- A. Method options
 - 1. Lecture/Demonstration
 - 2. Student inspection of navigation instruments
 - 3. Practical exercise using PPS
- B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises

V. Presentation

- A. Identify the principal components and explain the use of the following:
 - 1. Azimuth circle
 - 2. Telescopic alidade
 - 3. Stadimeter
 - 4. Sextant
- B. Discuss the general operating characteristics of the following:

1. Pitometer log
 2. Doppler speed log
 3. Fathometer
 4. DRT, its speed and direction input sources and its output of geographic motion
 5. Sextant
- C. Discuss alternative types of plotting instruments available to the navigator.
1. Parallel rulers
 2. Parallel motion protractor (PMP)
 3. Weems and Parallel plotter
 4. Three-arm protractor
- D. Discuss the means of determining time aboard ship, including the accuracy of each timepiece.
1. Stop watches
 2. Wall clocks
 3. Chronometers
 4. Comparing watches
- E. Using the time-speed-distance logarithmic scale on the PPS, have the students complete several practical exercises determining speed or distance or time given the two remaining values.
- F. Demonstrate the use of the nautical slide rule to solve the distance = rate x time problem.
- G. Discuss the application of the 3-minute and 6-minute rules.
- H. Discuss weather measurement instruments used by the navigator's personnel on most ships.

1. Anemometer -- wind
2. Barometer -- barometric air pressure
3. Thermometer -- air temperature
4. Psychrometer -- determination of dew point

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 6

HOURS: 1

TITLE: Lines of Position (LOPs)/Fixes

I. Learning Objectives

- A. The student will comprehend how sources of visual ranges, visual bearings, and distance LOPs are selected, acquired and plotted.
- B. The student will comprehend which combinations of LOPs used in determining a fix are most reliable and desirable.
- C. The student will apply correct procedures to become proficient in plotting and labeling fixes.
- D. The student will comprehend the use of radar in piloting.
- E. The student will comprehend the use of danger bearings and apply correct procedures to plot and label such bearings.
- F. The student will comprehend the difference between a fix and an estimated position (EP) and know the proper labeling procedure for EPs.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapters 8, 10
- 2. Dutton's Nautical Navigation, Chapters 12, 14, 36
- 3. American Practical Navigator, Bowditch, Chapters 8, 21, 22, 23
- 4. Piloting and Dead Reckoning, Dunlap, Chapter 11
- 5. Radar Navigation Manual, Publication 1310
- 6. Marine Navigation Workbook

B. Student texts

1. Marine Navigation, Hobbs, pp. 129-134, 142-143, 144-147, 174-176
2. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. Position plotting sheets (PPS)
- C. Plotting instruments
- D. Large compass and parallel rules for chalkboard
- E. Computer/projection system or overhead projector
- E. PowerPoint slides
- G. Computer with projection system

IV. Suggested Methods and Procedures

- A. Method options
 1. Lecture
 2. Demonstration of plotting procedures
- B. Procedural and student activity options
 1. Complete assigned reading
 2. Complete assigned workbook exercises

V. Presentation

- A. Define LOP, fix, visual range, and visual bearing.
- B. Utilizing the chalkboard and transparencies, explain how each is obtained and labeled.
- C. Discuss which combinations of LOPs are most reliable and desirable.

- D. Briefly discuss the use of radar as a source of LOPs/fixes, specifically noting that radar is more accurate in range than in bearing.
- E. Discuss selection of the position of the fix when a triangle is obtained when LOPs intersect.
- F. Discuss and demonstrate the use, plotting, and labeling of danger bearings in piloting.
- G. Explain the differences and labeling between an estimated position (EP) and a fix.
- H. Assign a practical plotting exercise.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 7

HOURS: 1

TITLE: Dead Reckoning

I. Learning Objectives

- A. The student will know the seven rules of dead reckoning (DR).
- B. The student will apply proper procedures to become proficient in the techniques of maintaining the DR plot.
- C. The student will apply the three- and six-minute rules in DR plotting.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 8
- 2. Dutton's Nautical Navigation, Chapter 9
- 3. American Practical Navigator, Bowditch, Chapter 7
- 4. Piloting and Dead Reckoning, Dunlap, Chapter 10
- 5. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, pp. 134-138, 143-144
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. Position plotting sheets (PPS)
- C. Plotting instruments

- D. PowerPoint slides
- E. Large chalk compass and parallel rules
- F. Computer with projection system

IV. Suggested Methods and Procedures

- A. Method options
 - 1. Lecture
 - 2. Demonstration of plotting that incorporates DR rules
- B. Procedural and student activity options
 - 1. Complete assigned reading.
 - 2. Complete assigned workbook exercises.

V. Presentation

- A. Discuss the principles of DR and the reasons for plotting a DR.
- B. Discuss the seven rules for keeping a DR plot.
 - 1. Mark a DR position every hour on the hour.
 - 2. Mark a DR position at every course change.
 - 3. Mark a DR position at every speed change.
 - 4. Mark a DR position at the time of a fix or running fix.
 - 5. Mark a DR position at the time of obtaining a single line of position.
 - 6. Plot DR positions two fix intervals ahead of the last fix.
 - 7. Plot on the most optimum scale chart available.
- C. Using the chalkboard and/or transparencies, demonstrate how to plot a DR of a ship's course and speed vector.
- D. Explain the application of the three- and six-minute rules in DR.

- E. Demonstrate the proper plotting procedures for laying out an intended track.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 8

HOURS: 1

TITLE: Running Fixes

I. Learning Objectives

- A. The student will apply correct procedures for advancing two or more non-simultaneous, nonparallel lines of position to establish a running fix.
- B. The student will apply correct procedures to plot and label a running fix with bearings on different objects, a running fix with bearings on the same object, and a running fix advancing a distance circle of position.
- C. The student will comprehend the reliability of running fixes compared to simultaneous fixes.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 8
- 2. Dutton's Nautical Navigation, Chapter 12
- 3. American Practical Navigator, Bowditch, Chapter 8
- 4. Piloting and Dead Reckoning, Dunlap, Chapter 12
- 5. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, pp. 138-142
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. PowerPoint slides

- C. Position plotting sheets (PPS)
 - D. Plotting instruments
 - E. Large chalk compass and parallel rulers
 - F. Laboratory 4 (Appendix A)
 - G. Computer with projection system
 - H. Overhead projector (optional)
- IV. Suggested Methods and Procedures
- A. Method options
 - 1. Lecture
 - 2. Demonstration of plotting procedures
 - B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises
- V. Presentation
- A. Define a running fix and explain when it is needed.
 - 1. Explain inherent inaccuracies that multiply over time.
 - 2. Discuss the maximum length of time an LOP may be advanced in piloting.
 - B. Using the chalkboard or instructor-prepared transparencies, show how a running fix is constructed.
 - 1. Demonstrate procedures for advancing both bearing and range LOPs with the ship on constant course and speed.
 - 2. Demonstrate the same procedures for a running fix with the ship changing course and/or speed.
 - C. Explain the rules for obtaining a running fix.

1. Explain the need for an accurate DR.
 2. Do not advance LOPs more than 30 minutes.
- D. Assign a practical plotting exercise for homework.
- E. Go slowly and use very clear plotting techniques.
Students have trouble with this entire concept!

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 9

HOURS: 1

TITLE: Magnetic Compass/Gyrocompass: Theory and Error

I. Learning Objectives

- A. The student will comprehend the basic principles of the operation of the gyrocompass and its advantages and disadvantages.
- B. The student will apply correct procedures in determining and correcting for gyrocompass and magnetic error.
- C. The student will comprehend the differences between true, magnetic, gyrocompass, and relative direction reference systems, and apply proper procedures to make direction conversions from any one system to any other.
- D. The student will comprehend the basic principles of operation of the magnetic compass and its advantages and disadvantages.
- E. The student will comprehend the reasons for variation and deviation and how these affect the magnetic compass.
- F. The student will apply proper procedures in converting from true direction to compass direction and vice versa.
- G. The student will apply correct procedures to determine variation using navigation charts.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 9
- 2. American Practical Navigator, Bowditch, Chapter 6
- 3. Dutton's Nautical Navigation, Chapters 7 and 29

- 4. Marine Navigation Workbook
- B. Student texts
 - 1. Marine Navigation, Hobbs, Chapter 9
 - 2. Marine Navigation Workbook
- III. Instructional Aids
 - A. Gyro demonstrator (optional)
 - B. Chalkboard/whiteboard
 - C. Compass trainer, Device 1DK2 (optional)
 - D. PowerPoint slides
 - E. Charts 33, 42 and 12221 or substitutes
 - F. Computer with projection system
- IV. Suggested Methods and Procedures
 - A. Method options: Lecture/Demonstration
 - B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises
- V. Presentation
 - A. Describe the use of true, magnetic, and relative reference lines as the basis of determining and measuring direction aboard ship.
 - B. Describe the properties of a gyroscope that enable it to be used as a north-seeking gyrocompass.
 - C. Briefly summarize the operation, location, and physical characteristics of the gyrocompass and gyro repeaters aboard ship.
 - D. Illustrate how gyro error is determined.

1. Visual ranges
 2. Comparing known bearings or pier heading
 3. Trial and error adjustments of 3 LOPs
 4. Comparison to another compass of known error
 5. Celestial methods (will be discussed later)
- E. Illustrate how gyro error is labeled and compensated for using Gyro + (error) East = True, and/or other memory aids.
- F. Discuss the advantages and disadvantages of gyrocompasses.
- G. Describe the earth's magnetic field.
1. Magnetic poles versus geographic poles
 2. Field intensity as a function of latitude
 3. Local disturbances and secular change
- H. Define
1. Variation
 2. Deviation
 3. Degaussing
- I. Discuss and illustrate how to obtain variation from the compass rose or isogonic lines printed on a navigation chart.
- J. Describe how deviation values vary with ship's magnetic heading and techniques for tabulating deviation.
- K. Explain the use of the ship's deviation table.
- L. Describe swinging ship and briefly discuss compass adjustment.
- M. Discuss advantages and disadvantages of a magnetic reference.

- N. Provide examples and have students work several magnetic compass and gyrocompass problems, using the memory aid CDMVTAE (Can Dead Men Vote Twice At Elections).

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 10

HOURS: 1

TITLE: Tides, Tidal and Ocean Currents

I. Learning Objectives

- A. The student will comprehend general causes and types of tides.
- B. The student will know the more important tidal reference planes and their uses as depth and height references on nautical charts.
- C. The student will apply correct procedures in the use of the Tide Tables to construct a complete tide table for a locality of interest and to find the expected tide for a particular time or period of interest (optional).
- D. The student will apply correct procedures in the use of the Tide Tables to determine the clearance under a bridge or overhanging obstruction, or depth of water over a shallow bottom at a particular time or period of interest (optional).
- E. The student will comprehend the general causes and types of current.
- F. The student will know the information on currents contained on pilot charts and in current diagrams and charts.
- G. The student will apply correct procedures in the use of the Tidal Current Tables to construct a complete current table for a locality of interest and to find the expected current for a particular time or period of interest (optional).

Instructor Note: The computations of tide and current problems are optional. If this material is not covered, the theory of tides and currents may be combined and taught in one lecture.

II. References and Texts

- A. Instructor references

1. Marine Navigation, Hobbs, Chapter 11 and 12
2. Dutton's Nautical Navigation, Chapter 10 and 11
3. American Practical Navigator, Bowditch, Chapters 9
4. Piloting and Dead Reckoning, Dunlap, Chapter 13 and 14
5. Marine Navigation Workbook
6. Tide Tables, 1984, East Coast of North and South America
7. Tidal Current Tables, 1984, Atlantic Coast of North America
8. Planning Guide (Mediterranean), Sailing Directions Publication 130 (SDPUB 130)
9. Enroute Guide (Western Mediterranean), Sailing Directions Publication 131 (SDPUB 131)

B. Student texts

1. Marine Navigation, Hobbs, Chapter 11
2. Marine Navigation Workbook
3. Tide Tables, 1984, East Coast of North and South America (optional)

III. Instructional Aids

- A. PowerPoint slides
- B. Tide Tables, 1984
- C. Complete tide table form (optional)
- D. Chalkboard/whiteboard
- E. Chart 12221 or equivalent charts
- F. Computer with projection system

IV. Suggested Methods and Procedures

A. Method options

1. Lecture
2. Demonstration of tide table solution (optional)

B. Procedural and student activity options

1. Complete assigned reading
2. Complete assigned workbook exercises

V. Presentation

A. Explain the causes of tides.

B. Define basic terminology.

1. Sounding datum
 - a. Indicate location on navigation charts.
 - b. Point out depth and clearance information on charts.
 - c. Indicate reliability of sounding data as a function of survey.
2. Range of tide
 - a. Individual ranges
 - b. Mean ranges

3. Stand

C. Define the basic tide types.

1. Diurnal
2. Semi-diurnal
3. Mixed

- D. Explain spring and neap tides and relate them to astronomical configurations.
- E. Define the eight tidal reference planes.
- F. Discuss weather effects on tide levels.
- G. Work basic tide problems (optional).
 - 1. Explain the format of the tide table.
 - 2. Explain the format of the tide form.
 - 3. Find the time of high or low water.
 - 4. Find the height of tide at any time.
 - 5. Determine the clearance under a fixed bridge.
- H. Assign tide problems from the workbook (optional).
- I. Define:
 - 1. Ocean currents
 - 2. Tidal currents
 - 3. Wind-driven currents
- J. Discuss the information available for predicting ocean currents.
 - 1. Pilot charts
 - 2. Sailing Directions Publications 130 & 131
- K. Discuss major ocean current systems, e.g., Gulf Stream.
- L. Discuss the information available for predicting tidal currents and explain the format of each.
 - 1. Tidal Current Tables
 - 2. Tidal current diagrams
 - 3. Tidal current charts

4. Tidal current diamonds -- found on British Admiralty Charts
- M. Work tidal current problems using the current tables (optional).
1. Complete a daily tidal current table for a given locality.
 2. Compute tidal current velocity and direction for a station at a given time.
 3. Determine the time at a given station and date when the current velocity and direction will be at a desired value.
 4. Compute the duration of slack water for a given date and station.
- N. Assign tidal current problems from the workbook (optional).

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 11

HOURS: 1

TITLE: Precise Piloting

I. Learning Objectives

- A. The student will know the terminology used to describe a naval ship's tactical characteristics.
- B. The student will apply proper procedures in the use of advance and transfer to determine turn bearings during precision piloting.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 14
- 2. Dutton's Nautical Navigation, Chapters 12 and 14
- 3. American Practical Navigator, Bowditch, Chapter 8
- 4. Marine Navigation Workbook
- 5. Piloting and Dead Reckoning, Dunlap, Chapters 11 and 12

B. Student texts

- 1. Marine Navigation, Hobbs, Chapter 14
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. Chart (select a small area, large scale harbor chart)
- C. Plotting instruments
- D. PowerPoint slides

- E. Large chalkboard compass and parallel rulers
- F. Computer with projection system
- IV. Suggested Methods and Procedures
 - A. Method options
 - 1. Lecture
 - 2. Demonstration of plotting techniques
 - B. Procedural and student activity options
 - 1. Complete assigned reading
 - 2. Complete assigned workbook exercises
- V. Presentation
 - A. Define the terminology used in describing shiphandling characteristics.
 - 1. Advance and transfer
 - 2. Turning circle
 - 3. Tactical diameter, final diameter, and standard tactical diameter
 - 4. Standard rudder
 - 5. Angle of turn
 - B. Explain how shiphandling characteristics vary from ship to ship and with speed and angle of turn.
 - C. Discuss the use of the ship's tactical data tables/folder.
 - D. Explain the application of advance and transfer in piloting.
 - E. Discuss the importance of environmental and geographic factors in selecting a desirable anchorage.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 12

HOURS: .5

TITLE: Practical Piloting Exercise

I. Learning Objectives

- A. The student will apply correct procedures to lay out intended tracks and properly plot all courses and speed changes utilizing the six rules of the DR plot.
- B. The student will apply values of advance and transfer to the track for turn bearings.
- C. The student will apply correct procedures to record bearings and obtain fixes.
- D. The student will apply correct procedures to determine gyrocompass and magnetic compass error.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 3
- 2. Dutton's Nautical Navigation, Chapters 12-14
- 3. American Practical Navigator, Bowditch, Chapters 8 and 25-28
- 4. Piloting and Dead Reckoning, Dunlap, Chapters 11 and 12

B. Student text: Marine Navigation, Hobbs, Chapter 3

III. Instructional Aids

- A. Real Time Plotting Exercise I and script prepared by instructor or use of the NAVSIM computer software with navigation chart information programmed by instructor.
- B. Chart 12254: Eastern Bay and South River or other suitable small-area, large-scale chart.

- C. Plotting instruments
 - D. Bearing record book sheet
 - E. NAVSIM computer software and manual (optional)
 - F. Audio cassette player and prerecorded cassette of instructor-prepared script (optional)
 - G. Computer with projection system (optional)
 - H. Laboratory 5 in Appendix A
- IV. Suggested Methods and Procedures
- A. Method options
 - 1. Discussion of purpose
 - 2. Presentation of exercise
 - B. Procedural and student activity options: Review previous assignments.
- V. Presentation
- A. Distribute charts, navigation instruments, exercise sheet, and bearing record book page; if using NAVSIM, distribute a list of bearing targets.
 - B. If using the NAVSIM software, setup will depend on the number of computers. If only one computer is available, the instructor or another staff member should act as conning officer/CO and the QMC (if available) should transcribe the time and bearings to a transparency that can be projected on each round of bearings. The students should be organized in 3-man teams acting as navigator, plotter, and bearing recorder. The instructor should direct each team, in turn, to provide the post-fix update and course/speed change recommendations.
 - C. After students have laid out intended track, start the tape presentation or NAVSIM.
 - D. Students will record appropriate information on the bearing record book sample sheet.

- E. Upon completion of the tape or NAVSIM exercise, the instructor will critique the problem and examine student work.

VI. Supplemental Information

- A. Students should rotate through team assignments.
- B. Recommend that another staff member, in addition to instructor, be present to assist.
- C. Recommend that the instructor complete the problem prior to class and lay the correct track on a clear plastic sheet. This can be placed on the student's chart to determine if he/she has the proper answer. If using the NAVSIM, a scale printout of the problem may be obtained after the exercise and made into a transparency.
- D. An alternate exercise is presented in Laboratory 5 in Appendix A.

REAL TIME PLOTTING EXERCISE I

PART I - TRACK LAYOUT - Designed for Chart 12270

This real time practical exercise is designed to introduce you to a real time navigation situation such as you will encounter on any naval vessel.

Plot the following points on your chart and label them "A," "B," and "C."

"A" 076° 27' 00"W

38° 57' 35"N

"B" 076° 25' 00"W

35° 56' 00"N

"C" 090°T, 1050 yds from Thomas Point shoal light

Lay out your track from "A" to "B" to "C." Determine your courses and establish a turn bearing at PT "B" utilizing Thomas Point shoal light. For this exercise, advance will be 200 yds; transfer 100 yds. Speed throughout will be 9 knots. Fixes will be every 6 minutes, with the first one at 0900 plotting exactly at PT "A." The 0900 round will be given twice in order that questions can be asked of your instructor in the time in between. You should properly label your track, LOPs and fixes. Record all bearings taken, as well as gyrocompass and magnetic compass errors on the bearing record book sheet.

PART 2 - REAL TIME PLOTTING

After a short introduction by your instructor, you should lay out your track and turn bearing at PT "B." Ensure that they are labeled correctly. The real time plotting will be conducted in two-person teams. Each student will have the opportunity to record bearings and to plot. If you have any questions during the exercise, do not hesitate to ask your instructor.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 13

HOURS: 1

TITLE: Celestial Theory

I. Learning Objectives

- A. The student will know the ultimate goal of celestial navigation.
- B. The student will know the definitions of terms and components associated with the celestial and horizon systems of coordinates.
- C. The student will know the relationship between the terrestrial, celestial, horizon, and coordinate systems.
- D. The student will know the information that can be obtained from the practice of celestial navigation at sea.

Instructor Note: Lesson 13 is intended to introduce students to the basic concepts and theory of celestial navigation. Lesson 13 enables the student to understand the theory of celestial navigation and its relevance in the Navy.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapter 16
- 2. Dutton's Nautical Navigation, Chapters 26-28
- 3. American Practical Navigator, Bowditch, Chapter 15
- 4. Marine Navigation Workbook

B. Student texts

- 1. Marine Navigation, Hobbs, pp. 277-289
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. PowerPoint Slides
- B. Slate globe (optional)
- C. Chalkboard/whiteboard
- D. Video 25484: "Basic Celestial Concepts Theory"
(12 min.)
- E. Celestial navigation sphere (Device 1A24)
- F. VCR/Monitor
- G. Chalk compass/Divider
- H. Computer-aided instruction: CELNAV (optional)
- I. Computer with projection system

IV. Suggested Methods and Procedures

A. Method options

- 1. Video
- 2. Lecture

B. Procedural and student activity options

- 1. Complete assigned reading
- 2. Complete assigned workbook exercises

V. Presentation

A. Review of the terrestrial coordinate system

- 1. Terminology
 - a. Poles
 - b. Equator
 - c. Greenwich meridian (prime meridian)

- d. Latitude
 - e. Longitude
 - f. Great circle
 - g. Parallel
 - h. Meridian
2. Measurement: 1 minute of arc measured along a meridian, or other great circle on the earth, equals one nautical mile.
- B. Introduce concept of celestial navigation.
- 1. Explain that the ultimate goal of celestial navigation is the solution of spherical triangles to determine the position of a craft or vessel with respect to earth-oriented coordinates (latitude and longitude).
 - 2. Logical extension of the basic problem of fixing a ship's position.
 - 3. Celestial LOPs are plotted in a manner similar to terrestrial LOPs.
 - 4. Remainder of celestial navigation will be concerned with how these celestial LOPs are obtained.
 - 5. Assumption: Earth is fixed; celestial bodies move about the earth in a predicable pattern.
 - 6. Celestial sphere: Celestial bodies are assumed to be on the surface of a vast hollow sphere of infinite radius with the center of the earth as its center.
- C. Briefly discuss the information contained in the Nautical Almanac.
- D. Discuss the information that can be obtained from the practice of celestial navigation at sea.

1. A celestial fix from the observation of stars, planets, and/or the moon.
2. A latitude line from the observation of a body at meridian transit.
 - a. Explain how the altitude of Polaris determines latitude.
 - (1) A few small mathematical corrections from the Nautical Almanac can be applied to align Polaris with the North Pole.
 - (2) Polaris' alignment with the North Pole collapses the navigational triangle. The co-latitude and co-altitude sides are the same length, so Polaris' altitude must equal the observer's latitude.
 - b. Explain that the determination of latitude at LAN is similar to the determination of latitude by Polaris.
 - (1) The celestial triangle is collapsed, but the sun is not coincident with another corner of the navigational triangle.
 - (2) Observing the sun's altitude and obtaining its declination from the Nautical Almanac allows the observer to determine latitude.
 - (3) Illustrate how latitude can be obtained using one or more of the three possible meridian transit relationships between the observer and sun during a LAN observation.
 - (a) The sun's GP is located on the upper branch of the observer's meridian between the observer and the equator.
 - (b) The sun's GP is on the upper branch of the observer's meridian but in the opposite hemisphere from the observer.
 - (c) The sun's GP lies on the upper branch of the observer's meridian between the observer and the elevated pole.

3. Gyro error

- a. Explain how a Polaris azimuth sight provides compass error.
- b. Explain how a sun azimuth sight provides compass error.
 - (1) Briefly discuss the amplitude method at sunrise or sunset.
 - (a) Use a simple sunrise example.
 - (b) Assume the observer is at 10N latitude and that the sun has a declination of N20. The observer knows that they should see the sun at 060T $[90 - (20 + 10)]$. Any deviation from 060T is the result of gyro error.
 - (2) Briefly discuss the exact azimuth method.
 - (a) The sun does not have to be observed during sunrise or sunset.
 - (b) The true azimuth of the sun can be observed, then compared to a calculated value derived from information contained in the Nautical Almanac. Any difference is due to gyro error.
 - (3) Explain the procedure for computing the time of sunrise and sunset.
 - (a) Discuss the location of sunrise and sunset information in the Nautical Almanac.
 - (b) Work a sample problem to demonstrate the method for determining the zone time of sunrise/sunset at a given location.

COORDINATE SYSTEMS COMPARISON MATRIX

TERRESTRIAL	CELESTIAL	HORIZON
Equator	celestial equator	horizon
Poles	celestial poles	zenith, nadir
Meridians	hour circles, Celestial meridians	vertical circles
Prime meridian	hour circle of Aries, Greenwich celestial meridian, local celestial meridian	principal vertical circle, prime vertical circle
Parallels	parallels of declination	parallels of altitude
Latitude	declination	altitude
co-latitude	polar distance	zenith distance
Longitude	SHA, GHA, LHA of star	azimuth, azimuth angle

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 14

HOURS: 1

TITLE: Electronic Navigation

I. Learning Objectives

- A. The student will comprehend the theory and basic operating principles of electronic navigation to include: Global Positioning System (GPS), Inertial Navigation System (INS), Navigation Satellite (NAVSAT) system, Navigation Sensor System Interface (NAVSSI), and bottom contour navigation.
- B. The student will know the importance of correcting for differences between the GPS/NAVSSI and navigation chart datum.

II. References and Texts

A. Instructor references

- 1. Marine Navigation, Hobbs, Chapters 30 and 31
- 2. Dutton's Nautical Navigation, Chapters 15, 17, 18, 31
- 3. American Practical Navigator, Bowditch, Chapters 2 and 11

B. Student texts

- 1. Marine Navigation, Hobbs, Chapters 30, 31
- 2. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. Bottom contour chart
- C. PowerPoint slides
- D. Computer with projection system

IV. Suggested Methods and Procedures

A. Method options: Lecture

B. Procedural and student activity options: Complete assigned readings. May copy and handout from references.

V. Presentation

A. NAVSAT satellite navigation

1. Explain the principles of doppler shift as applicable to satellite navigation.
2. Discuss the components and operation of the NAVSAT system.
3. Discuss the accuracy of the NAVSAT system.

B. NAVSTAR GPS (Global Positioning System)

1. Explain how pseudo ranges are used to determine position.
2. Discuss the components of the GPS system.
3. Discuss the accuracy of the GPS system and correcting for differences with navigation chart datum.
4. Discuss military applications of GPS to include navigation.

C. Inertial navigation

1. Discuss the Inertial Navigation System's (INS) ability to provide continuous dead reckoning and indication of velocity and altitude.
2. Discuss the components of INS.
 - a. Gyroscopes
 - b. Accelerometers
 - c. Computer/Processor

3. Discuss the factors that affect INS accuracy.
- D. Navigation Sensor System Interface (NAVSSI)
1. Discuss NAVSSI's ability to use all available navigation information to determine ship's position.
 2. Discuss the accuracy of NAVSSI and correcting for differences with navigation chart datum.
 3. Discuss the fact that NAVSSI can send navigation information to various ship systems.
 - a. NTDS
 - b. JMCIS
 4. Discuss the fact that NAVSSI and ECDIS-N will ultimately replace paper charts with digital.
 5. Discuss the tasks that NAVSSI software will be able to perform.
 - a. Tide and current
 - b. Set and Drift
 6. Bathymetric navigation
 - a. Discuss the use of bottom contour chart and echo soundings to establish ship's position.
 - b. Discuss the components and basic operation of the fathometer.
 - c. Discuss the factors that affect the accuracy of the bathymetric navigation DR plot.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 15

HOURS: 1

TITLE: Geodesy and Datums

I. Learning Objectives:

- A. The student will understand the difference between relative and absolute accuracy.
- B. The student will understand the difference between a Geoid and Ellipsoid.
- C. The student will be able to define a datum.
- D. The student will understand the difference between a global and local datum.
- E. The student will be able to define the World Geodetic System 1984.
- F. The student will understand what a datum shift is and state the causes for major datum discrepancies.
- G. The student will understand the consequences of improper datums.
- H. The student will be able to list at least four examples of where datum discrepancies have affected U.S. forces.
- I. The student will know where to look for datum information and conversions on a chart.
- J. The student will know the purpose for the NIMA product GEOTRANS 2 and why it is useful.
- K. The student will understand the precautions when using charts with different datums and when passing position information to them.

II. References and Texts:

A. Instructor references

- 1. Dutton's Nautical Navigation, Chapter 2, pp. 14-17

2. American Practical Navigator, Bowditch, Chapter 2, pp. 15-21

3. Marine Navigation, Hobbs, Chapter 4, pp. 32-35

B. Student references

1. Dutton's Nautical Navigation, Chapter 2, pp. 14-17 (handouts)

2. American Practical Navigator, Bowditch, Chapter 2, pp. 15-21 (handouts)

3. Marine Navigation, Hobbs, Chapter 4, pp. 32-35

4. Marine Navigation Workbook

III. Instructional Aids

A. Chalkboard/whiteboard

B. PowerPoint slides

C. Computer with projection system

IV. Suggested Method(s) and Procedures

A. Method option: Lecture

B. Procedural and student activity options: Complete assigned reading

V. Presentation

A. Introduction (Geodesy)

1. Define the term: Geodesy

2. Explain the art and science of cartography and its basics

3. Explain cartography history and how it has progressed over the recent history

B. Geodesy principles

1. Define terms used in describing Geodesy
 - a. Spheroid
 - b. Ellipsoid
 - c. Geoid
2. Explain the important differences between spheroid, ellipsoid and geoid with respect to navigation.

C. Datums

1. Define datums.
2. Discuss the difference between global and local datums.
3. Define WGS-85 and discuss importance
4. Explain the importance of datum shifts.
5. Discuss where datum information is located on a chart.
6. Explain precautions when using charts with different datums.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 16

HOURS: 1

TITLE: Electronic Charts and ECDIS-N

I. Learning Objectives:

- A. The student will be familiar with the principal types of electronic charts.
- B. The student will understand the difference between an ECDIS and an ECS.
- C. The student will understand the different Electronic Chart formats and their advantages and disadvantages.
- D. The student will be familiar with the display characteristics of an ECDIS System.
- E. The student will understand the limits of an ECDIS based on the performance limits of sensors.
- F. The student will understand the U.S. Navy policy and plan on ECDIS Systems.
- G. The student will understand the risk of over-reliance on an ECDIS System.

II. References and Texts:

A. Instructor references

- 1. Dutton's Nautical Navigation, Chapter 4, pp. 42-47
- 2. American Practical Navigator, Bowditch, Chapter 14, pp. 199-215
- 3. Marine Navigation, Hobbs, p. 47

B. Student references

- 1. Dutton's Nautical Navigation, Chapter 4, pp. 42-47
- 2. American Practical Navigator, Bowditch, Chapter 14, pp. 199-215

3. Marine Navigation, Hobbs, p. 47

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. PowerPoint slides
- C. Computer with projection system

IV. Suggested Method(s) and Procedures

- A. Method option: Lecture
- B. Procedural and student activity options: Complete assigned reading

V. Presentation

A. Introduction Electronic Charts

- 1. Background
- 2. ECS and ECDIS-N definitions
- 3. Components of ECS and ECDIS-N

B. Types of Electronic Charts

- 1. Raster charts (advantages-disadvantages)
- 2. Vector charts (advantages-disadvantages)
- 3. Define NIMA DNC's (advantages of DNC charts)

C. Navy's Policy on ECDIS-N

- 1. Status of the fleet
- 2. Platforms using ECDIS-N

D. NAVSSI and ECDIS-N

- 1. Define and explain the difference and how they are used.

2. Explain the different variable that can be inputted into NAVSSI and ECDIS-N capable systems.

E. ECDIS-N

1. History and manufacture
2. Applications
- 3.** Advantages and disadvantages of ECDIS-N

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 17

HOURS: 1

TITLE: Electronic and Radar Navigation

I. Learning Objectives:

- A. The student will be able to draw the basic diagram of the components of a radar set.
- B. The student will outline the principles and characteristics of radar.
- C. The student will be able to discuss the limitations of radar.
- D. The student will be able to describe the use of radar in navigation.
- E. The student will gain an understanding of the functional positions on a typical shipboard piloting team and radnav team.
- F. The student will be familiar with how a piloting team and radnav team operate.

II. References and Texts:

A. Instructor references

- 1. Dutton's Nautical Navigation, Chapter 15, pp. 154-163
- 2. American Practical Navigator, Bowditch, Chapter 13, pp. 187-197
- 3. Marine Navigation, Hobbs, Chapter 10, pp. 166-176
- 4. Radar Navigation and Maneuvering Board Manual, PUB 1310

B. Student references

- 1. Dutton's Nautical Navigation, Chapter 15, pp. 154-163 (handouts)

2. American Practical Navigator, Bowditch, Chapter 13, pp. 187-197 (handouts)
3. Marine Navigation, Hobbs, Chapter 10, pp. 166-176
4. Marine Navigation Workbook

III. Instructional Aids

- A. Chalkboard/whiteboard
- B. PowerPoint slides
- C. Computer with projection system

IV. Suggested Method(s) and Procedures

- A. Method option: Lecture
- B. Procedural and student activity options: Complete assigned reading

V. Presentation

A. Introduction

1. Background: The term "RADAR" is derived from Radio Detection And Ranging. It uses radio waves to determine the range and bearing of objects from the radar antenna. The time difference between a signal being transmitted and the returning echo being received is used to calculate the range; the direction that the antenna was on at that time (the azimuth) is the bearing.
2. Uses: Radar is used for a wide variety of purposes, including long range detection of aircraft, monitoring the weather, guiding weapons, and surface navigation. Each use requires certain special functions, but the basic components of a radar system are similar in each case. In this lesson, the components of a radar set will be described. The manner in which the information is displayed and the factors affecting radar's performance will be examined. Finally, the use of radar for navigation will be addressed.

B. Radar Components -- Every radar system, no matter what its purpose, has the following five major components (define and explain terms.)

1. Transmitter
2. Modulator
3. Antenna
4. Receiver
5. Display

C. Limitations

1. The physical characteristics of the radar signal impose some limitation upon the accuracy of the radar and include: beam width, pulse length and control adjustments.
2. Operator proficiency will also have an effect on accuracy.
3. Define and explain the following terms:
 - a. Resolution in Bearing
 - b. Resolution in Range
 - c. Frequency and Wavelength
 - (1) Propagation
 - (2) Antenna
 - (3) Sensitivity Time Control (STC)
 - (4) Fast Time Constant (FTC)
 - (5) Changing pulse length
 - d. Radar range
 - e. Radar navigation

f. Radar beacons

D. Discuss and explain advantages and disadvantages of radar

1. Advantages:

- a. May be used at day or night and in poor visibility.
- b. Usually more accurate than most other methods during periods of poor visibility.
- c. Fixes may be available at greater distances from land than from other piloting methods (i.e., visual piloting).
- d. A fix may be obtained from just a single object.
- e. Can be used to assist in collision avoidance.
- f. May be used to detect the presence of heavy precipitation.

2. Disadvantages:

- a. It is subject to mechanical and electrical failure.
- b. There are both maximum and minimum range limitations.
- c. Interpretation of the display is not always easy.
- d. It is less accurate than visual piloting.
- e. Small objects may not be detected in high sea states.
- f. Requires transmission from ship, which may not be tactically desirable.

E. Discuss Integrated Navigation Radars. More sophisticated radars are in use today that not only provide bearing and range information, but also perform the following functions:

1. Contact tracking and collision avoidance provided with an Automatic Radar Plotting Aid (ARPA) radar.
 2. When integrated with an ECDIS, the radar provides an overlay to the electronic chart in use, displaying the location of land, contacts, and navigation information on one display.
 3. Display navigation track information on the radar set.
 4. Displays identification of ships equipped with the Automatic Information System (AIS).
- F. Piloting Team. Discuss and explain the importance to the piloting team to include watch team members.
- G. Review and summary

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 18

HOURS: 1

TITLE: Weather

I. Learning Objectives

- A. The student will know the principles of basic weather phenomena, including fronts and subtropical and tropical storms.
- B. The student will know the relationship between wind and current in a wind-driven current system.
- C. The student will know the earth's major wind and current systems.
- D. The student will know how wind velocities relate to storm warnings and their effects on sea state.
- E. The student will know the sources of environmental predictions, including pilot charts and weather broadcasts.
- F. The student will know the characteristics of the approach of tropical storms and hurricane/typhoon evasion techniques.

II. References and Texts

A. Instructor references

- 1. American Practical Navigator, Bowditch, Chapters 34-37
- 2. Weather for the Mariner, Kotsch, pp. 31-71, 121-127, 137-168, 185-196
- 3. Surface Ship Operations, Chapter 4
- 4. Watch Officer's Guide, Chapter 9,

B. Student text: Surface Ship Operations, Chapter 4

III. Instructional Aids

- A. Pilot charts
- B. Computer/projection system or overhead projector
- C. Chalkboard/whiteboard
- D. Video 25488DN: "Meteorology (Hurricanes)", 1971 (25 min.)
- E. VCR/Monitor

IV. Suggested Methods and Procedures

- A. Method options
 - 1. Lecture
 - 2. Video
- B. Procedural and student activity options: Complete assigned reading.

V. Presentation

- A. Weather: Basic systems
 - 1. Discuss the causes of and the general air flow around the planet. Discuss the development of permanent pressure areas and constants such as trade winds.
 - 2. Discuss the development, movement, and winds associated with high and low pressure systems.
 - 3. Discuss the formation, movements, and weather associated with weather fronts.
 - 4. Discuss the general storm conditions associated with weather fronts.
 - 5. Discuss the formation of clouds and the significance of different types of cloud formations.
 - 6. Discuss the relationship between wind and current in wind-driven current systems.

7. Identify the earth's major wind and current systems.
8. Discuss the sources of environmental predictions, including pilot charts and weather broadcasts.

B. Tropical storms

1. Discuss how wind velocities relate to storm warnings and their correlation to sea states (Beaufort Scale).
2. Discuss the development of tropical cyclones and the sustaining factors of the storm. Discuss the locations and frequencies of these storms.
3. Define the following terms:
 - a. Dangerous semicircle
 - b. Navigable semicircle
 - c. Crossing the "T"

C. Hurricane/Typhoon evasion

1. Discuss the best maneuvering procedures for very heavy seas.
2. Discuss the best maneuvering procedures to avoid storm effects based on the ship's position in relation to the storm.
3. Discuss a ship's heavy weather bill and proper safety precautions during heavy weather conditions.

D. Show "Meteorology (Hurricanes)" video and summarize.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 19

HOURS: 2

TITLE: "The *USS Gonzalez* (DDG-66) Grounding" Case Study

I. Learning Objectives

- A. The student will comprehend the responsibility of naval officers to ensure the safety of their ships and crews.
- B. The student will comprehend the leader's importance of responsibility and accountability at all levels in the chain of command.
- C. The student will comprehend the value of a thorough Navigation Brief.
- D. The student will be able to identify poor watchstanding and navigation practices and ways to eliminate them in his or her efforts to prevent grounding a vessel.
- E. The student will comprehend the importance of information feedback to mission effectiveness.

II. References and Texts

- A. Instructor reference: "USS Gonzalez (DDG-66) Grounding" Case Study (Appendix B)
- B. Student text: "USS Gonzalez (DDG-66) Grounding" Case Study (Appendix B/Handout)

III. Instructional Aids

- A. Course syllabus
- B. Chalkboard/whiteboard
- C. Computer/projection system or overhead projector

IV. Suggested Methods and Procedures

- A. Method options: Discussion
- B. Procedural and Student Activity Options: Complete

assigned reading.

V. Presentation

- A. Define accountability/responsibility as: Liable to be called on to answer; able to answer for one's conduct and obligations.
- B. Lead a discussion relating the above points to the *USS Gonzalez* case study. It is the students' job to analyze the conduct of the CO, NAV, OOD, and other watchstanders onboard the grounded destroyer.
 - 1. Discuss the responsibilities of the OOD.
 - a. What are the responsibilities of the OOD?
 - b. In what ways did the OOD fail to meet these responsibilities?
 - (2) The OOD failed to make himself aware of the geographic factors that might affect safe navigation of the ship.
 - (3) The OOD failed to supervise personnel on watch on the bridge to ensure their performance was within expected standards.
 - (4) The OOD failed to review the chart in use and failed to ensure that a present and projected ship's position were determined to a reasonable degree.
 - c. What factors affected the OOD's decision-making process?
 - (1) Difficulties in stowing the ship's ladder and casting off the CHT barge forced a late underway (0818 vice 0800). Consequently, the changed contact situation forced the ship to alter its intended underway track.
 - (2) A poor navigation brief failed to discuss all navigation hazards within the vicinity of the *USS Gonzalez*, which caused the OOD to make decisions without knowledge or regard for Proselyte Reef.

- (3) Conflicting reports from the navigator.
- 2. Discuss the responsibilities of the other watchstanders.
 - a. What were the responsibilities the CIC watch team?
 - (1) The CIC watch team failed to keep the OOD advised of navigational hazards.
 - (2) The CIC officer failed to keep himself apprised of the status of the navigation evolution as he was preoccupied with preparations for upcoming events.
 - b. In what ways did the leading quartermaster and CIC watch team fail to meet their responsibilities?
- 3. Discuss the responsibilities of the navigator.
 - a. What were the responsibilities of the navigator?
 - b. In what ways did he fail to meet these responsibilities?
 - (1) The NAV failed to maintain an accurate plot of ship's position by any means.
 - (2) The NAV failed to ensure a ship's DR was plotted.
 - (3) The NAV failed to give proper attention to the course of the ship and the depth of the water as it approached Proselyte Reef.
 - (4) The NAV failed to reconcile differences between the CIC and bridge plots.
 - (5) The NAV failed to advise the OOD of a safe course to steer.
 - (6) The NAV failed to highlight or discuss all shoal water in the vicinity of the ship during the navigation brief.

4. Discuss the responsibilities of the commanding officer.
 - a. What were the responsibilities of the commanding officer?
 - b. In what ways did he fail to meet these responsibilities? (The CO failed to ensure the safe navigation of the ship.)
5. Who should be held accountable for the grounding?
6. Does the navigator's failure to make proper reports or the officer of the deck's failure to adequately perform his duties affect the commanding officer's ultimate accountability?
7. Does a navigator's report that "course 180 is a good course, I concur with course 180," absolve the OOD's responsibility for standing the ship into danger if course 180 grounds the ship? Keep in mind that the Navigator is an experienced Surface Warfare qualified officer and that the Navigator can relieve the OOD if he feels the OOD is driving the ship without regard for navigational safety.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 20

HOURS: 1

TITLE: Purpose and Scope of International and Inland Rules

I. Learning Objectives

- A. The student will comprehend the purpose and significance of both the International and Inland Rules of the Road.
- B. The student will know the terminology associated with the Rules of the Road.
- C. The student will comprehend the benefits of case analysis of actual groundings, collisions, storm damage, and shipboard accidents and know the publications where such information may be found.

II. References and Texts

A. Instructor references

- 1. Navigation Rules, COMDTINST M16672.2D
- 2. A Mariner's Guide to the Rules of the Road, Tate
- 3. Farwell's Rules of the Nautical Road

- B. Student text: Navigation Rules, COMDTINST M16672.2D, pp. vi-11

III. Instructional Aids

A. Videos:

- 1. "The Halifax Incident", 1942 (7 min.)
- 2. "Svea/Newport Incident", 1943 (5 min.)

B. Chalkboard/whiteboard

C. VCR/Monitor

D. PowerPoint slides

E. Computer with projection system

IV. Suggested Methods and Procedures

A. Method option: Lecture

1. Prior to the first lesson on Rules of the Road, instructors are encouraged to review all available training aids to reinforce their understanding and to provide students with the most recent information and court rulings.
2. Present videos at appropriate times (optional).
3. Assign each student to review a case analysis of a marine disaster. Review the sources of such information, such as Surface Warfare magazine, Naval Institute Proceedings, and National Transportation Safety Board (NTSB) findings. Many sources may be found in unit libraries, and NTSB publications may be found in the government documents section of the university library. The following are good illustrative NTSB cases:
 - a. Coast Guard Cutter *Blackthorn* and tank ship *Capricorn*
 - b. *USS Radford* and M/V Saudi Riyadh
 - c. *SS Exxon Chester* and MV *Royal Sword*
 - d. *SS Santa Cruz II* and Coast Guard Cutter *Cuyahoga*
 - e. MV *World Nobility* and *SS Pennsylvania Getty*
 - f. *SS Yellowstone* and MV *Ibn Batouta*
 - g. U.S. Geological Survey Vessel *Don J. Miller II* and FV *Welcome*

B. Procedural and student activity options: Complete assigned reading.

V. Presentation

A. Discuss Rules of the Road

1. Purpose: To provide a uniform guide of rules for all mariners to follow. (Rules 1-3)
2. Importance (prevent collision, prevent loss of life, etc.)
3. Difference between the COLREGS and Unified Rules as determined by boundaries described in Navigation Rules
4. General rules

B. Discuss terms applicable to Rules of the Road (Rule 3)

1. Court interpretation and jurisdiction
2. Legal personality of a vessel
3. Doctrine of responsibility
4. Limited liability

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION I**

LESSON GUIDE: 21

HOURS: 3

TITLE: International and Inland Lights and Day Shapes

I. Learning Objectives

- A. The student will know the lights and day shapes required to be shown by the different types and classes of vessels operating in:
 - 1. Waters where the international "Collision Regulations" apply.
 - 2. Waters covered by the Inland Rules of the United States.
- B. The student will know the various signals which may be used in inland or international waters by vessels to indicate they are in distress and require assistance.

II. References and Texts

- A. Instructor references
 - 1. Navigation Rules, COMDTINST M16672.2D
 - 2. A Mariner's Guide to the Rules of the Road, Tate
 - 3. Farwell's Rules of the Nautical Road
- B. Student text: Navigation Rules, COMDTINST M16672.2D, Rules 20-31, 36-37

III. Instructional Aids

- A. Rules of the Road Slide Presentation
- B. Video: "City of Rome Incident", 1942 (5 min.)
- C. Slide projector
- D. Chalkboard/whiteboard

- E. Rules of the Road, Flash Cards, NAVEDTRA 10925
- F. Computer-Aided Software: Rules of the Nautical Road (optional)
- G. Computer with projection system
- H. PowerPoint slides
- I. VCR/Monitor

IV. Suggested Methods and Procedures

A. Method options

1. Completely present the International lights and shapes in each section.
2. Present video at appropriate time (optional). The "City of Rome Incident" examines the collision of a freighter (City of Rome) and a U.S. submarine in 1933. Thirty-seven sailors lost their lives as a result. This collision reinforces the proper placement of masthead and side lights and is the basis for the special submarine light in use today. The collision resulted from the ambiguity caused by physical placement of the submarine's navigational lights.
3. This lesson is designed to be divided into two 1.5 hour periods. The first presentation consists of rules 20-28 for 1.5 hours. The second presentation continues with rules 29-37.

- ##### B. Procedural and student activity options: Complete assigned reading.

V. Presentation

- ##### A. Definition of terms. Define terms in accordance with Navigation Rule #3: vessels, underway, restricted visibility, etc.
- ##### B. Lights
1. Describe the required navigational lights.

- a. Reason for displaying (Rule 20)
 - b. When to display present International and Inland Rules together (Rule 20)
 - c. Location (Rule 21)
 - d. Arc of visibility (Rule 21)
 - e. Distance/Range of visibility (Rules 21, 22)
 - f. Length of ship (Rule 22)
2. Discuss the lights required by the following vessels.
- a. Power-Driven Vessels Underway (Rule 23)
 - b. Towing and Pushing (Rule 24)
 - (1) Astern (including length of tow)
 - (2) Composite Units
 - (3) Vessels or objects being towed
 - c. Sailing Vessels Underway and Vessels Under Oars (Rule 25)
 - d. Fishing & Trawling Vessels (Rule 26)
 - e. Vessels Not Under Command or Restricted in Ability to Maneuver (Rules 27, 28)
 - f. Mine sweepers (Rule 27)
 - g. Constrained by draft (Rule 28)

VI. Presentation

A. Lights (continued)

- 1. Briefly review light terms and characteristics presented in previous lessons.
- 2. Continue discussion of lights required by the following vessels.

- a. Pilot vessels (Rule 29)
- b. Anchored (include length of ship) (Rule 30)
- c. Aground (include length of ship) (Rule 30)
- d. Seaplanes (Rule 31)
- e. Submarines
- f. Non-displacement craft (Rule 23)
- g. Law enforcement vessels

B. Dayshapes

- 1. Describe the dayshapes in terms of:
 - a. Location
 - b. Color
- 2. Discuss the dayshapes exhibited to show status of the vessel and identify the dayshapes for applicable vessels as described in navigation rules 23-31.

C. Distress signals, etc. -- Identify and discuss the following:

- 1. Definition of a sound and light signals (Rule 32)
- 2. Equipment for sound signals (Rule 33)
- 3. Maneuvering and Warning Signals (Rule 35)
- 4. Signals to attract attention (Rule 36)
- 5. Distress signals (Rule 37)
- 6. Additional light and sound signals (Rule 37)

INSTRUCTOR NOTE: As each difference between Inland and International Rules is encountered, discuss and clarify in class.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 22

HOURS: 3

TITLE: Steering and Sailing Rules

I. Learning Objectives

- A. The student will apply the Navigation Rules to deter own ship's vessel responsibility and "right of way" in approach situations.
- B. The student will comprehend the provisions of the Navigation Rules, which govern the navigation of vessels operated in sight of one another.
- C. The student will comprehend the provisions of the Navigation Rules, which apply to the navigation of vessels in any condition of visibility.
- D. The student will comprehend the provisions of the Navigation Rules, which govern the navigation of vessels in restricted visibility.
- E. The student will know the requirements of the Navigation Rules sound signals for all classes of vessels in all conditions of visibility.

II. References and Texts

A. Instructor references

- 1. Navigation Rules, COMDTINST M16672.2D
- 2. A Mariner's Guide to the Rules of the Road, Tate
- 3. Farwell's Rules of the Nautical Road

- B. Student text: Navigation Rules, COMDTINST M16672.2D, pp. 12-37

III. Instructional Aids

- A. Rules of the Road Slide Presentation
- B. Slide projector

- C. Chalkboard/whiteboard
- D. Computer/projection system or overhead projector
- E. Videos:
 - 1. "The Beaver/Selja Incident," 1943 (5 min.) (optional)
 - 2. "Melbourne/Evans Incident - I Relieve You Sir," 1975 (35 min.) (optional)
- F. VCR/Monitor (optional)
- G. PowerPoint slides
- H. Computer with projection system

IV. Suggested Methods and Procedures

- A. Method options
 - 1. Lecture/Discussion
 - 2. It is recommended the first hour cover the rules for navigation in any visibility condition. The second hour should cover restricted visibility navigation rules. The third hour should cover vessel navigation in sight of one another and sound signals.
- B. Procedural and student activity options: Complete assigned reading.

V. Presentation

- A. Present the rules that apply to vessels being operated in all conditions of visibility (Navigation Rules).
 - 1. Applicability of the rules (Rule 4)
 - 2. Proper lookout (Rule 5)
 - 3. Safe speed (Rule 6)
 - 4. Risk of collision (Rule 7)

5. Action to avoid collision (Rule 8)
 6. Navigation in narrow channels (Rule 9)
 7. Navigation in traffic separation schemes (Rule 10)
 8. If time permits, show optional video:
"Melbourne/Evans Incident--I Relieve You Sir."
- B. Discuss the rules for navigating vessels in sight of one another and applications (Rule 11).
1. Sailing vessels (Rules 12)
 2. Overtaking situation (Rule 13)
 3. Head-on situation (Rules 14)
 4. Crossing Situation (Rule 15)
 5. The actions of give-way and stand-on vessels (Rules 16, 17)
 6. Responsibilities between Vessels (Rule 18)
- C. Conduct of vessels navigating in restricted visibility (Rule 19)
1. Discuss the definition of restricted visibility.
 2. Define the term "safe speed."
 3. Discuss sound signals for vessels navigating in restricted visibility (Rule 35).
 4. Discuss requirements for proper lookouts and use of radar.
 5. The optional video, "The Beaver/Selja Incident," may be presented in this segment. Although the rules discussed have been superseded, the video presents excessive speed and failure to take proper action on hearing a fog signal forward of the beam. Note that the video's treatment of legal damage assessments following the collision is obsolete. Be sure to emphasize the present day "comparative

negligence" ruling as discussed in the Mariners Guide, page 6.

D. Sound signals required (Navigation Rule 34)

1. Maneuvering signals
2. Warning signals

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 23

HOURS: 1

TITLE: Maneuvering Board Fundamentals

I. Learning Objectives

- A. The student will comprehend the theory of relative motion.
- B. The student will comprehend "bearing drift" and apply the concept in determining relative motion.
- C. The student will know the correct terminology associated with the speed triangle and the relative plot.
- D. The student will know the use of the 3-minute rule.

II. References and Texts

A. Instructor references

- 1. Radar Navigation Manual and Maneuvering Board Manual, Publication PUB 1310
- 2. Maneuvering Board Workbook, NAVPERS 93440-A, pp. 1-1 through 4-6

B. Student text:

- 1. Radar Navigation Manual and Maneuvering Board Manual, Publication PUB 1310 (Instructor copies)
- 2. Maneuvering Board Workbook, NAVPERS 93440-A, pp. 1-1 through 4-6

III. Instructional Aids

- A. Training Device 6605-00-240-05717: Wall-mounted maneuvering board
- B. Large parallel rulers (chalkboard)
- C. Large dividers 18" (chalkboard)

- D. PowerPoint slide or transparency of maneuvering board
- E. Computer/projection system or overhead projector
- F. Chalkboard/whiteboard
- G. Video: Relative Motion and the Maneuvering Board, 24177DN, 12 min. (optional) (NOTE: Copies of this video are no longer available; however, if a unit still has a copy, it would fit in well with this lesson.)
- H. VCR/Monitor (optional)

IV. Suggested Methods and Procedures

A. Method options

1. Lecture/Demonstration
2. The video may be used to illustrate the concept of relative motion. Preview the video prior to classroom use.

B. Procedural and student activity option: Work maneuvering board problems presented in the lesson and emphasize the following points during the lecture:

1. Only true vectors originate from the center of the maneuvering board. These true vectors represent the true course and speed of the reference and maneuvering ship.
2. All vectors should be labeled properly.
3. Work a problem one step at a time. An entire problem may seem complicated, but each step is simple, and the solution to the problem, as a whole, often depends on the ability to solve each separate step.
4. Explain that the 5:1 scale is normally used for the speed triangle in the fleet.
5. Demonstrate the use of the various speed/distance scales and the need to record the scale that is selected.

6. Demonstrate the use of the time/speed/distance nomogram.
7. Assign and complete problems in Laboratory Six (Appendix A).

V. Presentation

A. Relative motion

1. Define relative motion.
2. Discuss relative motion using real life examples. (Automobile situations provide excellent examples.)
3. Compare true motion with relative motion.
4. Define "closest point of approach" (CPA) -- bearing, range, and time. CPA is always expressed as bearing and range from ownship and the time at which that bearing and range occurs.

B. Bearings

1. Define "true bearing."
2. Define "relative bearing."
3. Using the formula "true bearing = ship's heading + relative bearing (TB = SH + RB)," demonstrate how to convert bearings.
4. Define "target angle" and give examples to show how it can be used to approximately determine the other ship's course and navigational threat. (Hint: Target angle can be best determined by imagining that you are on the other ship determining the relative bearing of your ship; the relative bearing determined equals target angle.)
5. Define "bearing drift" and how to determine whether it is left or right; describe how bearing drift can be used to determine relative motion.
6. Discuss the significance of constant bearing/decreasing range (CBDR) observations.

7. Discuss the cardinal and intercardinal points as illustrated by figure 2.1 on page 2-5 of the Maneuvering Board Workbook.

C. Plotting

1. Explain the layout of the maneuvering board plotting sheet.
2. Discuss the relative plot by relating the maneuvering board to a radar PPI scope.
3. Use examples of the relative plots to illustrate direction of relative motion (DRM), distance or measurement of relative motion (MRM), speed of relative motion (SRM), and CPA point (bearing and range).
4. Describe the proper labels for tracking the maneuvering vessel (M1, M2).

D. Speed triangle -- vector diagram

1. Develop the speed triangle.
2. Describe the proper labels for the speed triangle.
3. Discuss differences between the relative motion vector (rm) and true motion vectors (er and em).
4. Discuss the relationship between the relative plot and the speed triangle.
 - a. DRM is the common link, as it is a key part of both triangles.
 - b. Key points to discuss:
 - (1) True bearing and range are measured from the center.
 - (2) Relative quantities are never measured from the center.
 - (3) Direction of the rm vector is identical to the direction from M1 to M2 (DRM).

- (4) Time is always absolute.
- (5) Labeling: Relative plot - capital letters; speed triangle - lower case letters.
- (6) The relative plot represents bearing and range from reference ship (center); the speed triangle represents true courses and speeds.
- (7) Use of the 5:1 scale for speed.

E. Three-minute rule

- 1. Review the 3-minute rule: $\text{Speed} \times 100 = \text{distance traveled in three minutes (in yards)}$.
- 2. Discuss the possible uses of the 3-minute rule in solving maneuvering board problems. (Contact reports can be given at three-minute intervals.)
- 3. Drill students on the use of the 3-minute rule.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 24

HOURS: 1

TITLE: Basic Tracking and Stationing

I. Learning Objectives

- A. The student will apply the relative plot and the speed triangle to determine the closest point of approach (CPA), the time of CPA, and the true course and speed of the maneuvering ship using the maneuvering board.
- B. The student will apply procedures used to solve the maneuvering board speed triangle in practical problems in order to increase proficiency.

II. References and Texts

A. Instructor references

- 1. Radar Navigation Manual and Maneuvering Board Manual, Publication 1310
- 2. Maneuvering Board Workbook, NAVPERS 93440-A

B. Student text:

- 1. Radar Navigation Manual and Maneuvering Board Manual, Publication 1310 (Instructor copies)
- 2. Maneuvering Board Workbook, NAVPERS 93440-A, pp. 5-1 through 8-1.

III. Instructional Aids

- A. Training Device 6605-00-240-5717: Wall-mounted maneuvering board
- B. Large parallel rulers (chalkboard)
- C. Large dividers 18" (chalkboard)
- D. PowerPoint slide or transparency of maneuvering board sheet

- E. Computer/projection system or overhead projector
 - F. Chalkboard/whiteboard
- IV. Suggested Methods and Procedures
- A. Method options
 - 1. Lecture
 - 2. Problem solving demonstration
 - B. Procedural and student activity options:
 - 1. Demonstrate problems in class.
 - 2. Assign and complete problems in Laboratory Seven (Appendix A)
- V. Presentation
- A. Demonstrate solution to determine CPA using a sample problem. (Explain how to determine time of CPA by finding the maneuvering ship's course and speed.)
 - 1. Plot M1 and M2 points.
 - 2. Draw in DRM line from M1 to M2 and extend it, if necessary.
 - 3. Draw a line from the center that is perpendicular to DRM and label the intersection as the CPA point; measure CPA range and bearing.
 - B. Introduction to Tracking -- Determine the maneuvering ship's true course and speed.
 - 1. Construct ownship's er vector.
 - 2. Determine the actual distance between M1 and M2. This is the MRM.
 - 3. Based on elapsed time and MRM, determine the speed of relative motion (SRM) using the logarithmic scales at the bottom of the maneuvering board.
 - 4. Parallel the DRM line to the end of the er vector

and measure a vector, equal to SRM, from r in a direction of the DRM line; this is labeled rm. (Hint: Remind students this line is relative motion and the arrow points from r to m.)

5. Extend a third vector from the center to m; the vector em represents the course and speed of the maneuvering ship.
 6. Determine the time it will take the maneuvering ship to travel the distance from M2 to CPA at the speed of relative motion (SRM); then, determine time of CPA. (Time of CPA = Time at M2 + Time from M2-CPA.)
- C. Maneuvering board hints: Remind students of the maneuvering board techniques on pages 1-3 of their text; use these techniques in demonstration problems. (Figure 5-1 in the Maneuvering Board Workbook is an excellent example.)
- D. Introduction to Stationing. Define and discuss the following:
1. Base (guide's) course and speed (with guide both in and out of the center).
 2. Course and speed to reach new station.
 3. Time to reach new station.
 4. CPA to the guide.
 5. Bearing and range to guide when on new station.
 6. Minimum speed that may be used in proceeding to new station.
- E. Demonstrate solution of maneuvering board in stationing problems in the following circumstances:
1. Course to station is given.
 2. Proceeding to station as quickly as possible.
 3. Stationing speed is given.

4. Desired time of arrival at new station is given.
 5. Guide changes course, speed, or both while maneuvering ship is enroute to station.
 6. Passing no closer than a specified distance ahead/astern/abeam of the guide.
- F. During demonstrations, use basic maneuvering board techniques and labeling.
1. Guide should be in the center.
 2. Determine DRM line -- between old and new stations.
 3. Plot er vector and determine rm vector depending on variables above; then, solve for em, the course, and speed to station.
- G. Discuss normal rules for maneuvers in formations containing aircraft carriers.
1. Do not pass closer than 3,000 yards ahead, 2,000 yards abeam, or 1,000 yards astern of a carrier (3-2-1 rule).
 2. Demonstrate maneuvering board procedures for including a "dog leg" in the transit to a new station in order to conform with minimum approach distances.
 3. Explain why it may be desirable to maintain minimum passing distances between all maneuvering units.
 4. Discuss additional safeguards, such as the OOD or JOOD watching the carrier at all times when in a formation with a carrier.
- H. Discuss standards of accuracy expected in maneuvering board solutions.
1. Course or bearing: ± 3 degrees
 2. Speed: ± 3 knots
 3. Time: ± 3 minutes

4. Distance or range: ± 5 percent
- I. Describe a typical contact report that would be made to the commanding officer based on tracking information and the maneuvering board solution.
 1. Identification of speaker (i.e., "CO, this is the OOD.").
 2. Current relative bearing, range to contact.
 3. Bearing drift.
 4. CPA range, bearing, and time.
 5. Contact's course, speed, and target angle.
 6. Identification of contact.
 7. Which navigation lights can be seen at night?
 8. Your recommendation, based on rules of the road and the situation.
 9. Explain additional information they may choose to include (i.e., whether they have spoken to the contact, if the contact is unreachable, etc.).

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LESSON GUIDE: 25

HOURS: 2

TITLE: "Ramming of the Spanish Bulk Carrier *Urduliz* by the *USS Dwight D. Eisenhower* (CVN 69)" Case Study

I. Learning Objectives

- A. The student will comprehend the interrelationship between authority, responsibility, and accountability within an organization.
- B. The student will comprehend the importance of proper character development (founded in Core Values) as it relates to the principles of effective leadership.

II. References and Texts

A. Instructor references

- 1. "Ramming of the Spanish Bulk Carrier *Urduliz* by the *USS Dwight D. Eisenhower*" Case Study (attached)
- 2. Watch Officer's Guide
- 3. Naval Shiphandling, pp. 13-59 (optional)
- 4. Knight's Modern Seamanship, pp. 123-143, 241-305 (optional)
- 5. OPNAVINST 3120.32, "Standard Organization and Regulations of the U.S. Navy," Chapter 4, Articles 433 and 453

- B. Student text: Copy and distribute "*USS Dwight D. Eisenhower*" Case Study

III. Instructional Aids

- A. Course syllabus
- B. Chalkboard/whiteboard
- C. Computer/projection system or overhead projector

IV. Suggested Methods and Procedures:

- A. Lecture
- B. Discussion
- C. Role-play

V. Presentation

- A. Have the students read the "USS *Dwight D. Eisenhower*" Case Study prior to class.
- B. Review Lesson 11 of this guide.
- C. Discuss the accident.
 - 1. Do not simply reiterate the handout but have the students provide their interpretations. A role-play where students are assigned roles as participants in the accident or as members of a board of review may prove beneficial. The following four stages of the case may be used to help guide the discussion or may be a natural way to break down the case for students to present:
 - a. Investigation
 - b. Analysis
 - c. Conclusions
 - d. Recommendations
 - 2. When directing discussion regarding the accident, issues pertaining to authority, responsibility and accountability should be explored in detail. Be sure to include issues of proper watchstanding and Naval shiphandling, as it is easy to become too focused on one aspect of the incident.
- D. Have the students write a brief essay on a particular player who they feel displayed a lack of responsibility and/or accountability and what they would have done differently.

**Ramming of the Spanish Bulk Carrier *Urduliz*
by the *USS Dwight D. Eisenhower* (CVN 69)
Case Study**

EXECUTIVE SUMMARY

INVESTIGATION

Events Preceding the Accident

The Accident

Injuries to Persons

Damage to Vessels

Urduliz

Eisenhower

Crew Information

Urduliz

Eisenhower

Vessel Information

Urduliz

Eisenhower

Waterway Information

Meteorological Information

Other Information

U.S. Army Corps of Engineers Projects in the, Norfolk, Virginia,
Area

Entrance Reach Channel and Channel Marking

Anchorage

Pilotage

Bridge Personnel Relationships

Port Operations Department

Regulated Navigation Area, Elizabeth River, Norfolk, VA

Toxicological Testing of Navigation Personnel

ANALYSIS

The Accident

The Role of the Conning Crew

Pilotage

Bridge Environment and Crew Coordination

Waterway

Port Operations Department

Regulated Navigation Area, Elizabeth River, Norfolk, Virginia

Toxicological Testing of Navigation Personnel

Marine Accident Information Dissemination

CONCLUSIONS

Findings

Probable Cause

RECOMMENDATIONS

APPENDIXES

Appendix A -- Investigation

Appendix B -- Personnel Information

EXECUTIVE SUMMARY

At approximately 0820, on August 29, 1988, the nuclear-powered aircraft carrier USS *Dwight D. Eisenhower* (CVN 69), while entering the harbor at Hampton Roads, Virginia, struck the anchored Spanish bulk carrier *Urduliz*. The *Urduliz* was anchored adjacent to the Entrance Reach Channel waiting for a berth at the coal loading piers at Lamberts Point, Norfolk, Virginia. The *Eisenhower* was returning to its homeport of Norfolk, Virginia, after a 6-month deployment in the Mediterranean Sea. No one was injured. The accident resulted in \$2 million in estimated damage to the *Eisenhower* and \$317,128 in damage to the *Urduliz*.

The safety issues discussed in the report are:

1. The pilot employment practices of the U.S. Navy for its vessels transiting Norfolk harbor.
2. The location of the anchored *Urduliz* in relation to the channel.
3. The U.S. Navy harbor control of naval vessel traffic.
4. The non-navigational factors associated with the arrival from an overseas deployment that influence navigational decisions.
5. The Entrance Reach Channel width and navigation aids.

Recommendations concerning these issues have been made to the U.S. Navy and the U.S. Coast Guard.

The National Transportation Safety Board determines that the probable causes of this accident were the delayed and insufficient action to correct the *Eisenhower's* deviation from the intended track by the navigator and the officer of the deck because of inexperience in piloting the vessel through the restricted channel in Hampton Roads; the selection by the navigator of a course through the Entrance Reach Channel that did not compensate for the current and the wind; and the inadequate monitoring of the navigation of the vessel by the commanding officer. Contributing to the accident was the navigator's order to reduce the speed from 5 knots to 3 knots in an attempt to reach buoy "3" at a prescribed time and the inadequate guidance by the U.S. Navy on the use of pilots on large vessels.

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

MARINE ACCIDENT REPORT

**RAMMING OF THE SPANISH BULK CARRIER *URDULIZ*
BY THE USS *DWIGHT D. EISENHOWER* (CVN 69)
HAMPTON ROADS, VIRGINIA
AUGUST 29, 1988**

INVESTIGATION

Events preceding the Accident

On August 13, 1988, the 897-foot-long Spanish bulk carrier *Urduliz* (see figure 1) departed Gijon, Spain, for Norfolk, Virginia, to load a cargo of coal, as part of a long term charter to deliver coal to Gijon. At 1219, on August 25, 1988, the vessel arrived at Hampton Roads, southwest of Old Point Comfort, Virginia, and anchored in berth "Z," anchorage "A" (see figure 2), under the direction of a pilot from the Virginia Pilot Association. The pilot anchored the vessel near the center of the 1,500-foot radius of the circular-shaped berth as marked on the National Oceanic and Atmospheric Administration (NOAA) navigation chart numbered 12245 (47th edition, dated June 30, 1984; this was the latest edition of the chart). He used the port anchor and six shots (540 feet) of anchor chain to hold the *Urduliz* in the anchorage and departed the vessel at 1330. The vessel remained anchored awaiting a berth at the coal loading piers at Lamberts Point, Norfolk, Virginia. (See figure 3.) Anchor bearings recorded in the *Urduliz* deck log on August 25, and marked on its navigation chart, located the vessel's navigation bridge within 300 feet of the center of berth "Z." The bow of the *Urduliz* was about 1,200 feet north of the northern edge of the Entrance Reach Channel as marked on NOAA chart 12245. This was also about 600 feet north of the new northern edge of the channel delineated by the Newport News Channel Lighted Buoy "2" and the Thimble Shoal Channel Lighted Buoy "22" which had been repositioned on March 24, 1988. (See the section entitled "Entrance Reach Channel and Channel Marking" for more details.) At 0650, on August 29, 1988, the vessel's agent notified the master of the *Urduliz* to be ready to move the vessel from the anchorage to the coal piers at 0900. According to the master, at 0700, in preparation for the move, all navigational equipment, steering, and emergency maneuvering systems were tested and found to be satisfactory.

On August 27, 1988, after a 6-month deployment in the Mediterranean Sea, the 1,090-foot-long United States Navy (Navy) nuclear-powered aircraft carrier, the USS *Dwight D. Eisenhower* (CVN 69) (*Eisenhower*) (See figure 4) boarded about 500 "Tigers"¹ at Bermuda while on the final leg of its return voyage to its home port at Norfolk Virginia. During the afternoon of August 28, the junior officer of the deck/conning officer (JOOD) scheduled to conn² the *Eisenhower* into Norfolk conducted a navigation briefing for entering port with the commanding officer (CO), the officer of the deck (OOD), the navigator, and the navigation teams. The OOD stated that procedures for entering port, courses, speeds, changes to channels and buoy placement, and other matters affecting the vessel movement were reviewed. Navigation charts had been corrected by the chief quartermaster³ using the weekly Notice to Mariners No. 18/88 dated April 30, 1988, to show new buoy locations. The corrected charts were used to plan the vessel's arrival. That afternoon, all of the fixed-wing aircraft assigned to the *Eisenhower* were flown off the vessel to return to their home units ashore. During the morning of August 29, 1988, the remaining helicopters were flown off to Norfolk area airfields while the vessel was inbound from Cape Henry, Virginia.

The Accident

At 0716, on August 29, 1988, the *Eisenhower* was inbound in the Thimble Shoal Channel and passed through the southern opening of the Chesapeake Bay Bridge-Tunnel. (See figure 3.) The *Eisenhower* was proceeding at a speed of about 11 knots (55 RPM). On the bridge, there were at least 20 crewmembers for entering port: the CO, the navigator, the OOD, the JOOD, an officer liaison with the tactical operations plot (TOP) radar navigation team⁴ (he moved between the radar navigation compartment and the navigation bridge), several other officers, a chief quartermaster supervisor of visual navigation, a navigation plotter, a visual bearing recorder and sound-powered telephone talker, a deck log keeper, two helmsmen, a lee helmsman or engine order operator, two visual bearing takers, and several sound-powered telephone talkers connected to various stations throughout the vessel. In addition, there were 6 to 8 Tigers, news media representatives who interviewed the CO, and an undetermined number of other crewmembers on the bridge observing the activities. Sounds from orders and repeated orders, three radio channels, internal vessel telephones, flight operations, conversations, lookout reports, visual bearing reports, and other reports were heard on the bridge.

Many of the journalists and photographers who were embarked early on the morning of the accident for coverage of the port arrivals were on the flight deck at the time of the accident. While inbound, the Secretary of the Navy (SECNAV) and the Admiral in command of the Naval Air Force, Atlantic Fleet (COMNAVAIRLANT), arrived aboard the vessel via helicopter to formally welcome the crew of the *Eisenhower* on its return from its Mediterranean deployment. The COMNAVAIRLANT and the SECNAV departed the vessel via helicopter at 0732 and 0807, respectively.

At 0747, the *Eisenhower* exited Thimble Shoal Channel and continued on its course toward Old Point Comfort. At 0752, the OOD reduced speed to 10 knots (50 RPM). About 0753, the *Eisenhower* bridge watch sighted the *Urduliz* about 5 miles away. About 1 hour earlier, the bridge watch had been informed of a vessel anchored in berth "Z," anchorage "A," by the USS *Thomas C. Hart* (FF-1092), a naval vessel preceding them into Norfolk. About 0800, as the *Eisenhower* was approaching the turn at Old Point Comfort, the bridge watch received a bridge-to-bridge radio telephone call for a port-to-port meeting from a naval warship. The warship was "well off the port bow," and identified as a nuclear-powered attack submarine. Safety Board investigators determined the submarine to be the USS *Glenard P. Lipscomb* (SSN 685) (LIPSCOMB). Port Services had scheduled it for departure from its berth at the Naval Station at 0730, and it departed between 0730 and 0800. Also about 0800, the navigator confirmed, via radiotelephone, to the Naval Station's Port Operations Department that the *Eisenhower* would be arriving at the Elizabeth River Channel Lighted Buoy "3" (buoy "3") at the previously scheduled time of 0845, to embark a Navy docking pilot for docking the vessel at the Naval Station. At 0805, the OOD ordered the *Eisenhower*'s speed to be reduced to 5 knots (25 rpm). About 1 minute later, when the *Eisenhower* was about 0.6 nmi east of Old Point Comfort Light, the OOD ordered the course changed to the left to 229T from 258T. The new course of 229T was along the southern edge of anchorages "A" and "B" as marked on NOAA chart 12245 (47th edition). According to the CO, the vessel was following its preplanned track toward the northern edge of the Entrance Reach Channel and Hampton Roads. He also stated that on the new course, the wind would be coming from about 60 degrees off the port bow and a flood current of about 2 knots would be "pushing the vessel." The navigator stated that the computed wind was 23 knots on the port beam after the course change. At 0820, the meteorology officer on the *Eisenhower* determined the wind to be from 150T at 20 knots. The visual navigation plotting team was taking fixes at 2-minute intervals after leaving Thimble Shoal Channel and after the turn to the left obtained a fix at 0807. (See figure 2.)

The officers on the bridge of the *Eisenhower* observed the *Urduliz* anchored in anchorage "A," with its anchor chain leading forward under a moderate strain, with the bow pointing into the wind, towards the Entrance Reach Channel. The CO stated that the *Urduliz* heading was "just about perpendicular to our track,...." The officer on watch on the *Urduliz* estimated that his vessel was heading about 110T just prior to the accident. The navigator, OOD, and JOOD independently estimated, to themselves, that the *Eisenhower* would pass about 100 yards from the *Urduliz* and that the anchored vessel posed no hazard to their vessel.

The backup or radar navigation team took fixes at 3-minute intervals and advised the bridge that the vessel was "on track" at 0810, but the visual navigation team reported "no fix." At 0811, the navigator recommended that the OOD reduce speed to 3 knots (15 rpm) because the *Eisenhower* was about 4 minutes ahead of its scheduled time of 0845, for embarking the Navy docking pilot at buoy "3." The navigator recalled that he made the recommendation directly to the OOD "just loud enough to him to hear." The OOD then ordered the conning officer to reduce speed to 3 knots, who in turn, ordered the lee helm⁵ to order the new speed to the engine rooms. The navigator stated that the reason that he recommended that the OOD reduce speed was because: "I felt that---I had some check marks on my chart and I knew where I was supposed to be when, in order to make that estimate, and I was within 4 minutes, in my mind, of being there right on time." When asked about arriving 4 minutes ahead of schedule, the navigator replied, "It's professional to be at a position when you say you're going to be there and I wanted to do that." He said that he did not want to be at "buoy '3' earlier than that and not have a pilot and tugs coming at me,...[when we are] ready to start our process of going alongside the pier." At 0813, the radar navigation team reported that the *Eisenhower* was 25 yards to the right of the intended track. At 0814, the Admiral in command of the Battle Group, quartered in the *Eisenhower*, entered the navigation bridge and his presence was announced. When asked if it was normal for the Admiral to be on the bridge, the CO stated, "That was about his third--for the morning, about his third time on the bridge. He just came by, said, 'How are things going?' and left. It didn't create any disturbance and we don't all snap to attention or anything like that when he comes on the bridge. Someone announces the Admiral's on the bridge and boom-boom there he is and somebody announces when he leaves, the Admiral's left the bridge, if somebody notices. It wasn't a disturbance factor." As the 0816 radar fix was plotted in TOP, the TOP liaison officer observed that the fix was "well right, [I] went out [to the navigation

bridge] and told the navigator that the latest fix shows us at least 150 yards right, just to give him a heads up and the report came over the phone talker, officially to the OOD, the captain [CO] we were 200 yards right [of track]." The visual navigation team had not been able to obtain an acceptable fix between 0807 and 0817 and were unable to provide an explanation as to why. The chief quartermaster (chief) who was supervising the plotting of visual fixes said that at 0809 there was no fix, but that is not unusual to occasionally fail to get a fix because of missing the correct object or misreading a bearing number from the gyrocompass. But at 0810, there also was no fix. At that point, he believed that there may have been an equipment failure of some sort and had all the bearing takers check their equipment. The chief also said that the compass readings were within tenths of a degree of each other, "very minor." Attempts to get fixes continued at 1-minute intervals, but the navigation plotter could not get a fix. About 0815, the chief relieved the plotter and erased part of the plot. He had the bearing takers check their equipment again, identify and describe the objects that they were to take bearings of, and ordered another round of visual bearings. At 0817, the visual navigation team obtained a fix that determined the *Eisenhower* to be about 380 yards to the right of its intended trackline. The chief said that as he was preparing to make his report, the OOD and the CO were taking action to avoid the collision.

At 0817, the OOD ordered left 10 degrees rudder and the vessel began to change course to 225T from 229T; he also advised the CO that the vessel's speed had been reduced to 3 knots. The CO stated that he had not been aware that the navigator had recommended that the OOD slow the vessel to 3 knots or that the OOD had ordered the speed reduced. The CO further stated that he "did not hear the call to the lee helm to indicate one five RPM which is 3 knots, and as soon as I was aware of this happening I ordered him to increase speed to 5 knots." About 0818, as the bow of the *Eisenhower* passed the extended centerline from the bow of the *Urduliz*, the CO, navigator, and OOD realized that the bearing to the *Urduliz* was no longer changing and a collision was imminent. The CO estimated that the distance between the vessels was about 100 to 200 feet at the time. The CO stated that the 10 degree left rudder was inadequate and directed the OOD to increase the rudder to 20 degrees left, and then to 30 degrees left; the CO then took over the maneuvering of the vessel.

The Navy docking pilot, on a tug en route to the *Eisenhower*, was about 1 mile away and believed that the *Eisenhower* was going to collide with the anchored *Urduliz*. He said that he didn't

think the *Eisenhower* had much way (motion through the water), and was going sideways almost as fast as she was going ahead.

About 0819, the internal collision alarm and six blasts on the whistle (according to the Inland Navigation Rules, the danger signal is five or more blasts on the whistle) were sounded on the *Eisenhower*. The CO stated that he ordered "shift your rudder" (rudder moved from left 30 degrees to right 30 degrees), and the engines were stopped about 0820. The *Eisenhower* struck the *Urduliz* about 0820, when it was about 400 yards to the right of its intended track. The CO stated that the nuclear-attack submarine that had made the meeting agreement with them, was passing them in the Entrance Reach Channel on the port side, when the *Eisenhower* came into contact with the *Urduliz*. The submarine's berth was about 3.5 nmi from buoy "1ER." The *Eisenhower* struck the bow of the *Urduliz* with its starboard side between the No. 1 and No. 2 aircraft elevators. The bow of the *Urduliz* was caught under the overhang of the flight deck and the anchored vessel was dragged about 1,000 yards from its location in berth "Z," anchorage "A," to the southwest near the center of berth "Y," anchorage "B." The bow of the *Urduliz* also scraped along the starboard side of the *Eisenhower* for about 175 feet. The vessels remained together until 0833, when they separated without any action taken by either vessel.

The officer on watch (the third officer) on the *Urduliz* observed the *Eisenhower* approaching, but did not take any action or sound a danger signal because he believed that the vessel would come close but "would have sufficient measures to go by without colliding." However, he sent a messenger to notify the master of the potential danger. The first officer was in his room when he saw the *Eisenhower* approaching and went to the bridge. The master also observed the *Eisenhower* from a window in his office and proceeded to the bridge. On his way to the bridge, the master was met by the messenger. The master and the first officer arrived on the bridge of the *Urduliz* at the moment of collision. The master and the officer on watch did not hear the danger signal from the *Eisenhower*, but the officer on watch did hear the internal collision alarm sound from the *Eisenhower*. The master ordered the chief engineer to prepare the engine to be ready to answer bells and to start the emergency fire pump. He also ordered the first officer to the bow and to prepare to fight a fire, if necessary. The master and his deck watch stood-by on the bridge waiting for the Virginia Pilot Association pilot, who was en route, to move the *Urduliz* to the coal loading piers. About 0830, the pilot arrived on the bridge of the *Urduliz*. About 0837, after the vessels disengaged from one another, they were facing almost in

opposite directions, with the bow of the *Urduliz* heading about 075T. Tension on the anchor chain caused the starboard stern of the *Urduliz* to swing toward the starboard bow of the *Eisenhower*. To prevent a second collision, the pilot on the *Urduliz* ordered "hard right wheel, [and] a slow ahead bell..." and moved the vessel away from the *Eisenhower*. The pilot remained on the anchored *Urduliz* and at 1700, he piloted the vessel to the grain pier south of the Naval Station for a damage survey and temporary repairs.

The Navy docking pilot proceeded toward the *Eisenhower* after passing around the stern of the *Urduliz*. He did not see any propeller action from the *Urduliz* as he passed the vessel. At 0837, the CO ordered the rudder to right 30 degrees and the engines to slow astern. Shortly thereafter, the docking pilot arrived on the bridge of the *Eisenhower* and the CO passed the conn to the docking pilot. After taking over the conn, the docking pilot used four tugs on the port side of the *Eisenhower*, two on the bow and two on the stern, to push the *Eisenhower* further away from the *Urduliz*, and then proceeded to dock the vessel. At 0943, the *Eisenhower* was docked at the south side of pier 12, at the Naval Station.

Injuries to Persons. There were no injuries or deaths.

Damage to Vessels

Urduliz -- Damage to the *Urduliz* hull was confined to the bow above the waterline. The forecastle bulwark and deck were crushed and torn for a distance of about 12 feet aft of the stem on the centerline. The bow was also pushed in and holed into the forecastle. Permanent repairs to the *Urduliz* were accomplished between September 22 and 30, 1988, at the Bazan de Construcciones Navales Militares Shipyard, El Ferrol, Spain. The cost of temporary and permanent repairs of the damage to the *Urduliz* was about \$317,128. During the repair periods, the owners of the *Urduliz* sustained additional financial losses of \$341,587 for having the vessel out of service, for a total cost of \$658,715.

Eisenhower -- Damage to the *Eisenhower* hull was confined to the starboard side between 50 and 65 feet above the waterline, along the underside of the flight deck. The damage extended from about midpoint between No. 1 and No. 2 aircraft elevators at the flight deck, aft to a point about midway under the flight deck level of the "island" superstructure, a distance of about 175 feet. There was minor structural damage to the underside, of the No. 2 elevator; however, the damage did not affect its operation.

Walkways and safety nets were crushed and torn away from the underside of the flight deck. The CO's cabin located under the island was extensively damaged. In addition, 23 inflatable life rafts were dislodged from their stowed positions on the starboard side of the flight deck. Some of the life rafts came to rest on the forecastle of the *Urduliz*, while the others went into the water and were recovered by Coast Guard patrol boats. The cost of repairing the damage on the *Eisenhower* was estimated to be \$2 million. The repairs were completed in conjunction with the *Eisenhower*'s previously scheduled shipyard period between October 3, 1988, and March 10, 1989.

Crew Information

Urduliz -- There were 38 persons on board the *Urduliz* at the time of the accident; 36 crewmembers and 2 Spanish citizens carried as persons in addition to the crew. All crewmembers were Spanish citizens who were either licensed or documented by the Spanish government. The master of the *Urduliz* had held his position on the vessel for about 2 1/2 months, the period of time that the present owner had owned the vessel. He had been working for this company for 24 years and been master of several of their vessels for 15 years. The master had been going to sea for the past 34 years and had held a master's license for 26 of those years. The third officer had held his position on the vessel for about 20 days and had been aboard 4 months during the early part of 1988, when the vessel was owned by another company. He had been going to sea for the past 13 years.

Eisenhower -- When fully manned, the *Eisenhower* carried a crew of 6,042 officers and enlisted men, consisting of 3,105 in the ship crew, 72 marines, and 2,865 in the air wing.⁶

The CO, a 51-year-old aviator with the rank of captain, assumed command of the *Eisenhower* in October 1986. At the time of the accident, he had served in the Navy as a commissioned officer for about 28 years and had accumulated almost 14 years of sea duty. Immediately before his assignment to the *Eisenhower*, he had served 2 years as the CO of the combat stores auxiliary vessel USS *Niagara Falls* (AFS-3), preceded by almost 3 years as executive officer (XO) on the nuclear-powered aircraft carrier USS *Carl Vinson* (CVN-70), a sister vessel to the *Eisenhower*. While assigned to the *Vinson* and the *Eisenhower*, he had completed numerous transits of Hampton Roads. Prior to his assignment as XO of the *Vinson*, about 7 years of his 14 years of sea duty was on aircraft carriers as an aviator assigned to various aviation units.

The CO reported that during the night before the accident, he slept in his cabin between 2130 and 0430. He said that he had slept well, interrupted by only a few calls about vessel traffic. He awoke at 0430, went to the bridge, and remained there throughout the morning. He stated that he felt rested and that his judgment had not been impaired by fatigue.

The navigator, a 42-year-old aviator with the rank of commander, was assigned as navigator of the *Eisenhower* in November 1986. At the time of the accident, he had served in the Navy as a commissioned officer for about 20 years. Prior to this assignment, he had about 2 1/2 years of sea duty, from September 1976, to January 1979, on board the aircraft carrier *Midway* (CV 41), stationed in Japan. He served as assistant navigator and qualified as OOD. Upon assignment to the *Eisenhower*, he completed the navigation officer shipboard celestial navigation course and a 2-day practical shiphandling course. He qualified as Command Duty Officer (CDO) (underway)⁷ in February 1987. He was the navigator during the *Eisenhower's* coastal, Latin American, and Caribbean operations, when the vessel was brought to readiness for fleet operations prior to departure to the Mediterranean Sea on February 29, 1988. He accrued a career total of 4 years of non-aviation sea duty in two assignments as assistant navigator and navigator aboard two aircraft carriers (MIDWAY and *Eisenhower*, respectively) in the preceding 12 years before this accident, which were separated by 8 years of aviation assignments. Prior to the date of this accident, he had completed numerous transits of Hampton Roads while assigned as the navigation officer on the *Eisenhower*. He said that he "got 8 hours plus sleep the night of the 27th, which is embarrassing for a navigator." He also said that during the evening before entering Norfolk harbor (28th), he had "...plenty of sleep;" he slept 6 hours between 2100 and 0300, with two brief interruptions. He awoke at 0300, and arrived on the bridge at 0330.

The OOD, a 32-year-old aviator with the rank of lieutenant, was assigned as assistant navigator on the *Eisenhower* in June 1987, for his first shipboard assignment. At the time of the accident, he had served in the Navy as a commissioned officer for about 10 years. He served as assistant navigator during the *Eisenhower* coastal, Latin American, and Caribbean operations before departing on the Mediterranean Sea deployment. He became qualified as OOD (underway) in August 1987. He had never served as OOD during a transit of Hampton Roads. He said that during the evening before entering Norfolk harbor, he had 5 hours sleep, awoke at 0300 and arrived on the bridge at 0345 to assume the

duties of navigation officer-of-the-watch. At 0530, the vessel's navigator assumed the duties of navigation officer-of-the-watch and the assistant navigator assumed the duties as OOD for entering port.

The CO, navigator, and OOD each reported that they were in good health and not suffering from any chronic or acute ailments or illnesses at the time of the accident. Each reported that his vision and hearing were within normal limits. This investigation disclosed no evidence of adverse medical history, chronic, or acute ailments to suggest that the performance of any member of the navigation crew was adversely affected by his physical condition. (See appendix 8 for additional details about the crew.)

Vessel Information

The principal characteristics of the two vessels are as follows (see figure 5):

	<u>Urduliz</u>	<u>Eisenhower</u> ⁸
Length	897 feet	1,090 feet
Breadth	128 feet	134 feet
		252 feet (flight deck)
Depth	64.3 feet	68 feet
Draft at		
Time of Accident	22.5 feet (forward)	36 feet
	28.5 feet (aft)	
Loaded Draft	47.6 feet	39 feet
Gross Tonnage	53,728	---
Deadweight Tons	106,476	---
Displacement Tons	---	91,700 (loaded)
		70,916 (light)
Horsepower	24,750	280,000

Urduliz -- The *Urduliz*, Lloyd's Register of Shipping number 7320526, originally named *Urquiola*, was built in December 1973, by Astilleros Espanoles DCN S.A., Bilbao, Spain, as a tank vessel. After a grounding and fire in May 1976, the forward and cargo sections were replaced in August 1983, at the Bazan de Construcciones Navales Militares Shipyard, El Ferrol, Spain. The rebuilt vessel was renamed *Argos*. The cargo tanks of the rebuilt *Argos* were strengthened to enable the vessel to carry heavy bulk cargoes. In May 1988, the vessel was purchased by its present owner, Naviera Vizcaina S.A., Bilbao, Spain, and renamed *Urduliz*.

The *Urduliz* was a single-rudder, single-screw, motor vessel powered by a two-cycle, single-acting 9 cylinder diesel engine. The deckhouse was located aft and it had a raised forecastle. The navigation bridge was located about 745 feet aft of the bow and the height of eye⁹ was about 84 feet above the waterline. Between the forecastle and the deckhouse were nine cargo holds/tanks. It had a normal bulk carrier bow, with the bow flaring forward about 15 feet from the hull at the 50-foot height above the keel to the forecastle bulwark to minimize deck wetness. The top of the bow bulwark was about 82.5 feet above the keel.

The *Urduliz* was equipped with standard navigational equipment, including two Raytheon marine radars, one Raytheon collision avoidance radar, one Magnavox satellite navigation system, one Decca navigation system, and one loran-C navigation system, one ITT direction finder, one Japan Marine Company fathometer, and an Anschutz gyroscope compass with a repeater on each bridge wing. The navigation charts for Hampton Roads had been corrected to show the latest buoy locations.

Eisenhower -- The *Eisenhower* was the third nuclear-powered aircraft carrier built at the Newport News Shipbuilding & Drydock Company, Newport News, Virginia. It was commissioned for service in the United States Navy on October 13, 1977. The ship had two rudders, four propellers, and was powered by four steam turbines. Main propulsion steam was provided by two Westinghouse nuclear reactors. The *Eisenhower* had a top speed in excess of 30 knots. The vessel cost approximately \$1.9 billion to build.

The navigation bridge was in the superstructure on the starboard side of the flight deck, known as the "island," about 673 feet aft of the bow. The height of eye on the navigation bridge was about 45 feet above the flight deck and about 108 feet above the waterline. The starboard side of the bridge was offset outboard from the starboard side of the hull about 60 feet and about 106 feet from the vessel centerline. The flight deck creates a "shadow area" within which small floating objects cannot be seen. The extent of the area obstructed from view varies depending upon the height of the observer above the deck. From the navigation bridge, the area obstructed varied from about 620 yards on the bow, to about 195 yards on the port beam, and to about 357 yards on the stern (see figure 6).

The *Eisenhower* navigation bridge measures about 40 feet from port to starboard and about 10 feet from forward to aft. Extending out from the starboard after corner of the bridge was an auxiliary conning station. It measured about 6 feet by 6 feet

square. This station had windows on three sides for visibility from forward to aft on the starboard side of the vessel. The main navigation bridge windows provided a view to starboard, forward, to port, and a full view of the flight deck forward and aft. On the after side of the bridge was a passageway on each side leading from the bridge, and the TOP compartment forming the center after bulkhead. (See Figure 7.)

The *Eisenhower* navigation bridge was equipped with a Raycas V marine radar, a Furuno radar, two radar repeaters, a Northstar loran receiver, a Shipmate Decca receiver, two satellite receivers, a fathometer, and five gyroscope compass repeaters (one at the chart table on the starboard forward corner, one on the port side aft by a window, two in the auxiliary conning station, and one that was on a 5-foot track at the forward center windows). The helm, engine order telegraph, two gyroscope compasses, and a magnetic compass were in a console to the left and aft of the center windows. There were two stationary chairs: one for the CO on the port side forward of the after gyroscope compass repeater and one for the navigator on the starboard side aft of the chart table.

All navigation equipment was operating properly both before, during, and after the accident. The navigation charts for Hampton Roads had been corrected to show the latest buoy locations.

Waterway Information

Norfolk, Virginia, is located at the southeastern part of the state and at the southwestern corner of the Chesapeake Bay. The U.S. Naval Station piers at Norfolk are located about 18 nmi west of the entrance to the Chesapeake Bay from the Atlantic Ocean. To reach the piers, vessels from the ocean must transit Thimble Shoal Channel, which crosses the southern end of the Chesapeake Bay; pass through the bridge opening at the lower end of the Chesapeake Bay Bridge-Tunnel; pass between Old Point Comfort on the north and Fort Wool on the south; transit the Entrance Reach Channel at Hampton Roads; and enter the Norfolk Harbor Reach Channel which is adjacent to the west side of the Naval Station. The channels are maintained at a minimum depth of 45 feet. (See the "Other Information" section for more details on the channels.) Except for areas close to shore, the water is about 18 feet deep from the Atlantic Ocean to Hampton Roads. The channel boundaries are marked by numerous buoys along the route. The buoys are generally 1/4 nmi apart near turns to about 1 nmi apart along straight sections of a channel.

The predicted tidal currents calculated by the Safety Board from the Tidal Current Tables¹⁰ for 0.55 nmi east of Old Point Comfort (37 00.12'N, 76 17.72'W) for August 29, 1988, were:

<u>Time</u>	<u>State of Current</u>	<u>Speed</u>	<u>Direction</u>
0421	slack water	0.0	----
0807	flood	1.7 knots	251T
0931	maximum flood	2.2 knots	251T

The predicted tidal currents calculated by the Safety Board for 0.2 nmi south of Old Point Comfort (36 59.77'N, 76 18.88'W) for August 29, 1988, were:

<u>Time</u>	<u>State Of Current</u>	<u>Speed</u>	<u>Direction</u>
0646	slack water	0.0	---
0815	flood	1.5 knots	240T
0938	maximum flood	2.7 knots	240T

The predicted tidal currents calculated by the Safety Board for 0.2 nmi northwest of Fort Wool (36 59.3'N, 76 18.42'W) for August 29, 1988, were:

<u>Time</u>	<u>State of Current</u>	<u>Speed</u>	<u>Direction</u>
0614	slack water	0.0	---
0815	flood	1.6 knots	240T
0851	maximum flood	2.1 knots	240T

The predicted tidal currents calculated by the Safety Board for mid-channel off Old Point Comfort (36 59.3'N, 76 19.3'W) for August 29, 1988, were (see figure 2 for the locations of the predicted currents):

<u>Time</u>	<u>State of Current</u>	<u>Speed</u>	<u>Direction</u>
0646	slack water	0.0	---
0815	flood	1.2 knots	260T
0951	maximum flood	2.5 knots	260T

Shortly after the accident, the Coast Guard checked the position of the Thimble Shoal channel buoys "21" and "22", and Entrance Reach Channel buoys "1ER," "3," and "5," and found them to be operating properly and at the position as required on the navigation charts of the area, as corrected by and listed in the weekly Notice to Mariners No.18/88 dated April 30, 1988.

Meteorological Information

The weather as reported by the meteorological officer on the *Eisenhower* was 6 miles visibility, air temperature 78.5 F, wind direction from 150T at 20 knots, and 2-foot "wind" waves. The prevailing winds from March through August and November through January are from the southwest, in February from the north-northeast, and in September and October from the northeast. The temperatures are generally mild with about 2 days of heavy fog per month.

Other Information

U.S. Army Corps of Engineers Projects in the Norfolk, VA, Area. -- In 1969 and 1970, dredging of the channels to a depth of 45 feet was completed in the Hampton Roads area and the Thimble Shoal Channel. According to the U.S. Army Corps of Engineers' (COE) Project Engineer for Dredging Management, Norfolk, the depths and channel configurations were maintained accordingly, until recently. In 1986, the COE was authorized under a project entitled "Norfolk Harbor and Channels, Virginia" to dredge channels in the Hampton Roads area and Thimble Shoal Channel to a depth of 55 feet, in two phases. During phase I, which was completed December 15, 1988, the COE dredged 650 feet of the outbound-side of the 1,000-foot wide channels at Thimble Shoal, Entrance Reach, Newport News, and Norfolk Harbor Reach to a depth of 50 feet and the remaining 350 feet on the inbound-side were maintained at 45 feet. The Entrance Reach Channel was also reduced in width from 1,500 feet to 1,000 feet. The COE expects to commence phase II, dredging the 650-foot channel width to the 55-foot depth and the 350-foot side to the 50-foot depth, in fiscal year 1991.

Entrance Reach Channel and Channel Marking. -- The Entrance Reach Channel is located between Old Point Comfort and Fort Wool on the east and Sewells Point in the west, where it joins the Newport News Channel and the Norfolk Harbor Reach Channel. Prior to March 30, 1988, the southern side of the Entrance Reach Channel was marked with the Elizabeth River Channel Lighted Horn Buoy (LHB) "1" (buoy "1") near Fort Wool and the Elizabeth River Channel Lighted Buoy "3" (buoy "3") northwest of Sewells Point. A line drawn between the buoys marked the southern edge of the 45-foot channel. The northern side of the channel was located on the southern edge of anchorages "A" (berth "Z") and "B" (berths "X," "Y," and "W"), and generally on a line drawn between the Naval Ordnance Lighted Buoy "T" (buoy "T") east of Old Point

Comfort and the Newport News Channel Lighted Buoy "2" (buoy "2"). The distance between buoy "T" and buoy "2" is about 3.5 nmi. The width of the channel was 1,500 feet.

On March 24, 1988, Thimble Shoal Channel Lighted Buoy "22" (buoy "22"), near Thimble Shoal Light, was relocated close to the eastern side of Old Point Comfort. There are no buoys between buoy "22" and buoy "2" on the "new" northern side of the Entrance Reach Channel a distance of about 3.2 nmi. When the Coast Guard witness was asked how the northern side of the channel will be delineated from the anchorage, he said that: "There will be no markings adjacent to the channel or demarcation line adjacent to the channel. Generally, when you put buoys near an anchorage, they get run over and they serve only as a hazard to navigation." A vessel on a course coinciding with a line drawn between relocated buoy "22" and buoy "2" would be encroaching on the southern edge of anchorages "A" and "B."

On March 29, buoy "3," also located on the south side of the channel, was relocated about 200 yards to the north, on the 50-foot water depth contour curve. On March 30, 1988, buoy "1," located on the southern side of the channel, was relocated about 700 yards to the west at the edge of the 50-foot water depth contour curve and renamed buoy "1ER." As a result of these changes, the Entrance Reach Channel became 1,000 feet wide between the lines created by buoy "22" and buoy "2" (on the northern side) and the Elizabeth River Lighted Buoy "1ER" (buoy "1ER") and buoy "3" (on the southern side). Further, the new location of these buoys on the southern side of the channel, and the southern edge of anchorages "A" and "B" on the northern side of the channel, as marked on the navigation charts available at the time of the accident, reduced the width of the channel available south of Anchorages' "A" and "B" to about 700 feet near buoy "1ER" and to about 900 feet near buoy "3." The charts on the *Eisenhower* and the *Urduliz*, in use on the date of the accident, had been corrected with these buoy changes.

The CO of the *Eisenhower* testified about the new channel configuration and said that "...there's not adequate room for two ships to pass. Not carrier-size ships or a carrier-size ship and a submarine."

Anchorages. -- The anchorages in the Hampton Roads area at the time of the accident are described in the regulations at Title 33 Code of Federal Regulations (CFR) Subpart 110.168. In the Hampton Roads area, there are a number of anchorages for use by commercial and naval vessels. Counter-clockwise from Old Point

Comfort to Newport News, Virginia, the anchorages were designated: "A," "B," "C," "E," "D," "H," and "F-1." Anchorage "A" was reserved for commercial vessels undergoing examination for quarantine, customs, or immigration. It was also used by deep draft vessels waiting for a dock to load or unload cargo. Vessel masters were not required to obtain permission to anchor in this anchorage. In the southeast corner of the anchorage was located the 1,500-foot-radius berth "Z." The edge of the radius of berth "Z" was about 650 feet north of the northern edge of the Entrance Reach Channel before the channel was narrowed. After it was narrowed, the outer edge of berth "Z" was about 300 feet from the channel edge. Anchorage "B" was a deep water Naval anchorage. Within the anchorage boundaries were located three circular 1,800-foot-radius berths: "W," "X," and "Y." The southern boundary of anchorages "A" and "B" (berths "W," "X," "Y," and "Z") was also the northern edge of the previous Entrance Reach Channel, but it was not marked by any buoys.

On March 22, 1984, the Coast Guard published an advance notice of proposed rulemaking announcing its intention to review and amend the anchorage regulations for Hampton Roads and adjacent waters. The proposal was made to accommodate the intended construction of the Newport News Bridge-Tunnel, a proposed widening and deepening of the Newport News Channel, and the construction of a Navy ammunition barge mooring facility in anchorage "B." The Coast Guard stated that after the proposal was published "there were a multitude of meetings held with the Virginia Pilot Association, industry groups and the U.S. Navy to discuss changes to the anchorages and channel realignment/markings." No other proposals were published until June 3, 1988, when the Coast Guard published a notice of proposed rulemaking to completely revise the special anchorage areas, anchorage grounds, and regulated navigation areas in the Hampton Roads area. The proposal to revise the regulations was prompted by dredging projects that had been completed, were in progress, or were planned for the Hampton Roads area and "a culmination of those meetings, discussions and negotiations [held between 1984 and 1988]." One of the changes adopted was the renaming of anchorages "A," "B," and "C" to "F," "G," and "H." Anchorages "A" and part of "B" became anchorage "F," parts of anchorages "B" and "C" became anchorage "G," and the remaining part of anchorage "C" became anchorage "H." Berths "X" and "Y" (in anchorage "B") and berth "Z" (in anchorage "A") were renamed to berths "G2," "G1," "F1," and "F2," respectively. (See figure 8.) The southern boundary of anchorages "G" and "F" were moved northward in order to be aligned with the new northern edge of the Entrance Reach Channel. Berth "F2" has roughly the same southern position as the

previous berth "Z" and is about 100 yards north of the new channel edge. The final rules were published in the Federal Register on January 9, 1989, and became effective on February 8, 1989.

Pilotage. -- The State of Virginia requires foreign vessels, or U.S. registered vessels departing on or returning, from a foreign voyage to engage the services of a State pilot (pilot). The Federal government requires a Coast Guard licensed pilot on a U.S. commercial vessel of 1,600 gross tons or more on a coastwise voyage while the vessel is in U.S. "pilotage waters." The master of a U.S. commercial vessel on a coastwise voyage can satisfy this requirement by employing a State pilot with a Federal license or independent Federally licensed pilot, or by utilizing a member of the vessel's crew who has been issued a Coast Guard pilot's license for those waters. Federal law excludes military and other public vessels from State or Federal pilot requirements.

There are two state pilot associations for the Chesapeake Bay: The Association of Maryland Pilots, and The Virginia Pilot Association (VPA). The pilots in these associations are licensed to pilot any foreign or domestic vessel to any respective Maryland or Virginia port. There is also a Federal pilot association: the Chesapeake and Interstate Pilots (C & IP) whose members pilot domestic vessels not on foreign voyages on the waterways for which they are licensed by the Coast Guard. All pilots are embarked and debarked at the entrance to Chesapeake Bay.

The Navy in Norfolk, Virginia, does have contracts with pilot associations and pilots are available for use by naval vessels. The Naval Station Port Operations Department will arrange for a pilot for a naval vessel upon request. If the pilots are not ordered through the Naval Station, then the services are charged to the requesting vessel's funds. In November 1985, the C&IP was awarded the Navy contract for piloting its vessels in the Chesapeake Bay area. The association's six pilots reported that between November 1985 and November 1988, they piloted about 292 naval ships of all sizes, most of which were large deep draft vessels (vessels with drafts in excess of 25 feet). Each C&IP pilot averages about 50 commercial ship transits a year in the Hampton Roads area. According to the Commander, Naval Station (COMNAVSTA), Norfolk, Virginia, between October 1, 1987, and September 30, 1988, 2,028 Naval vessels arrived or departed the Naval Station or the Craney Island Fuel Depot, southwest of the Naval Station. The Navy did not have any vessel movement data for other locations in the Hampton Roads area.

Between November 1984 and November 1985, the last year that the VPA had the Navy piloting contract, the approximately 51 VPA pilots piloted 146 naval ships of all sizes, most of which were larger deep draft vessels. Each VPA pilot averages about 170 commercial vessel transits a year in the Hampton Roads area.

Officers, including CO's, of Navy vessels stationed in Norfolk revealed that Navy vessels transiting Hampton Roads do not routinely utilize the services of pilots between the entrance to Chesapeake Bay and buoy "3," as use of these pilots is viewed by some as a reflection that the vessels crew had less than a professional shiphandling ability. The navigator of the *Eisenhower* also said that it was uncommon for a Navy ship to embark a pilot going in or out of Norfolk, but that he had discussed doing so with the CO while planning the port arrival. The navigator of the *Eisenhower* said that: "I told him [CO] what I had learned [from a visit to the VPA station at Cape Henry, Virginia] and told him what their capabilities seemed to be and he [the CO] said, 'well, I don't think we need a pilot, but really I'll leave that to you. If you really feel strongly that we need a pilot, we'll get a pilot.' So I thought about it for a period of time...and made my own determination that we just did not need a pilot."

When the CO of the *Eisenhower* was asked about the policy of the Navy to utilize pilots, he replied, "I couldn't answer what the Navy policy is, I really don't know." The CO's responsibility concerning pilotage is set forth in Navy regulations at Title 32 CFR Subpart 700.754, and the CO's responsibility for safe navigation of his vessel is set forth in Subpart 700.755(a).

32 CFR 700.754: Pilotage.

(a) The commanding officer shall:

- (1) Pilot the ship under all ordinary circumstances, but he may employ pilots whenever in his judgment such employment is prudent.
- (2) Not call a pilot on board until the ship is ready to proceed.
- (3) Not retain a pilot on board after the ship has reached her destination or point where pilot is no longer required.
- (4) Give preference to licensed pilots.

(5) Pay pilots no more than the local rates.

(b) A pilot is merely an adviser to the commanding officer. His presence on board shall not relieve the commanding officer or any of his subordinates from their responsibility for the proper performance of the duties with which they may be charged concerning the navigation and handling of the ship. For an exception to the provisions of this paragraph, see "Rules and Regulations Covering Navigation of the Panama Canal and Adjacent Waters," which directs that the pilot assigned to a vessel in those waters shall have control of the navigation and movement of the vessel. Also see the provisions of these regulations concerning the navigation of ships at a naval shipyard or station, or in entering or leaving drydock.

32 CFR 700.755(a): Safe navigation and regulations governing operation of ships and aircraft.

(a) The commanding officer is responsible for the safe navigation of his ship or aircraft except as prescribed otherwise in these regulations for ships at a naval shipyard or station in drydock, or in the Panama Canal. In time of war or armed conflict, competent authority may modify the use of lights or other safeguards required by law to prevent collisions at sea, in port, or in the air. In exercises, such modifications will be employed only when ships or aircraft clearly will not be hazarded.

Bridge Personnel Relationships. -- The OOD's relationship with the CO is stated in Navy Regulations at Chapter 10, article 1008: "Every person on board who is subject to the orders of the commanding officer, except the executive officer, and those other officers specified in article 1009, shall be subordinate to the officer of the deck." His relationship to the navigator is stated in Navy Regulations at chapter 10 article 1009 subparagraph 3: "The navigating officer shall advise the officer of the deck of a safe course to be steered and the officer of the deck shall regard such advice as sufficient authority to change the course, but shall at once report the change to the commanding officer..." Article 1011: "Except as prescribed in these regulations or as authorized by the commanding officer, the officer of the deck shall not change the prescribed course or speed of the ship unless necessary to avoid collision or imminent danger." Article 1020: "Reports by the Officer of the Deck. The officer of the deck shall promptly report to the commanding officer all matters which affect or which may affect the safety of the ship...or changes in course or speed made by the ships in company or by himself..."

The CO and the navigator both said that the navigator recommends course and speed changes to the OOD and the OOD orders the conning officer to make changes to the helm or the engines. The navigator does not give conning orders directly to the conning officer.

Port Operations Department. -- The Port Operations Department, in accordance with U.S. Navy Regulations, as the agent for the COMNAVSTA, Norfolk, Virginia, schedules the movement of vessels at the Naval Station and naval vessels transiting Hampton Roads. The requirements for the "Movement of Ships at a Naval Station" are set forth in U.S. Navy Regulations at Chapter 7 paragraph 0751:

--1. No ship or craft shall be moved or undergo dock trials during its stay at a naval station, except by direction or with approval of the commanding officer of such station.

--2. A ship arriving at, or departing from, a naval station shall be furnished such assistance, including tugs, when available, as in the opinion of the commanding officer of the naval station or the ship may be necessary for her safe handling.

The COMNAVSTA reported that every Thursday, the Naval Station conducts a berthing conference with all area squadrons and groups to determine the following week's vessel movements. Each squadron and group presents its vessels' requested movement times and the Port Operations Department prepares the final schedule based on tide constraints (if the vessel is deep draft), fleet operational commitments, availability of tugs and docking pilots, and vessel request/preferences. The schedule can be modified to accommodate changing conditions. Vessels may dock or undock without the use of tugs or docking pilots, but their arrival or departure times are still coordinated with the Port Operations Department for shoreside services and to avoid conflict with other naval vessel movements in the harbor.

After receiving notice of arrival information from any large vessel scheduled to berth at the Naval Station Norfolk, the Station will advise the vessel of the time that it should be at the buoy "3," if tugs have been requested. If tugs have been requested, then a Naval Station docking pilot would be furnished. Destroyers and smaller vessels may also request these services, if desired. Tugs and a Naval Station docking pilot will meet the vessel and maneuver it into the pier. Docking pilots usually board aircraft carriers between buoy "1ER" and buoy "3." When large deep draft vessels are assigned to berth on the south side of the piers at the Naval Station, they are scheduled to arrive on

the flood current at Hampton Roads. Flood current keeps the vessel off the south side of the pier, enabling tugs to control the movement of the vessel as they push the vessel slowly into the Pier. The *Eisenhower* was arriving on the flood current because it was to moor on the south side of pier 12.

Regulated Navigation Area, Elizabeth River, Norfolk, Virginia. -- Under "Restrictions on Vessel Operations During Aircraft Carrier and Other Large Naval Vessel Transits of the Elizabeth River" at Title 33 CFR Paragraph 165.501(d)(11), formerly Title 33 CFR Subpart 165.505, the Coast Guard has established a regulated navigation area (RNA) to restrict the navigation near large naval vessels by other vessels. This regulation requires that:"...no vessel may, without the permission of the [Coast Guard] COTP, come within or remain within 500 yards from a naval aircraft carrier or other large naval vessel, which is restricted in its ability to maneuver in confined waters, ...transiting the Elizabeth River between the Norfolk Naval Base, Norfolk, Virginia, and the Norfolk Naval Shipyard..." (about 11 miles south of the Naval Station).

The regulations were requested by the Navy in 1982, and became effective on June 6, 1983. The preamble to the regulations stated that the Navy requested the regulations to prevent accidents due to the reduced maneuverability of the vessels caused by the slow speeds at which the vessels had to operate in the restricted channels between the Naval Station and the Shipyard. When the RNA for the Elizabeth River was designated around aircraft carriers in 1983, the Norfolk Harbor Reach Channel adjacent to the Naval Station was 1,500 feet wide. It is now 1,000 feet wide.

If the Navy requests the COTP to establish an RNA around an aircraft carrier or other large naval vessel traversing the Elizabeth River, when granted, the Coast Guard broadcasts Notice to Mariners. The COTP normally provides two patrol boats to control traffic: one boat about 500 yards ahead and one about 300 yards astern of the large vessel.

Toxicological Testing of Navigation Personnel. -- The use of alcohol and illicit drugs is prohibited aboard the *Eisenhower*. After the accident, navigation personnel were not asked to provide specimens for toxicological testing, nor were they required to do so.

Navy instruction, OPNAVINST 5350.4, provides policy guidance for substance abuse prevention and control for Navy personnel. A CO, or an officially appointed investigation board convened for a safety investigation, "such as an aircraft mishap investigation," may order drug tests for a member's involvement in a serious accident or incident in which safety precautions were violated or unusually careless acts were performed. However, there are no specific guidelines in the Navy instruction similar to the Federal regulations for commercial vessel accidents. The chemical testing of Navy vessel crewmembers is not required by the Navy, when a Navy vessel is involved in an accident with a non-military vessel in U.S. waters, or with another U.S. vessel in any waters.

The Safety Board has previously addressed post-accident toxicological testing of Navy personnel following the collision between the USS *Richard L. Page* (FFG 5) and the U.S. Fishing Vessel *Chickadee* in the Atlantic Ocean on April 21, 1987.¹¹ After that accident, members of the navigation crew of the *Page* were not required or asked to provide specimens for examination. The Safety Board recommended to the Navy:

Amend OPNAVINST 5350.4 (Substance Abuse Prevention and Control) to require drug testing of U.S. Navy personnel directly involved in an accident with a U.S. civilian vessel in international waters or any civilian vessel in U.S. waters.
(Class 11, Priority Action) (M-88-38)

The recommendation is classified as "Open-Awaiting Response."

ANALYSIS

The Accident

At the time of the accident, the *Urduliz* was anchored in a designated anchorage (anchorage "A," berth "Z") with its bow about 400 yards from what had been the northern edge of the Entrance Reach Channel prior to March 30, 1988, or about 200 yards from the new channel edge established by buoy relocations on March 30, 1988. The pre-planned track of the *Eisenhower* in the Entrance Reach Channel was to follow the northern edge of the previous 1,500-foot-wide channel (this was also the southern limits of anchorages "A" and "B"). The *Eisenhower* bridge watch was aware that the *Urduliz* was anchored in berth "Z," as the bridge watch had been informed about 1 hour before the accident by a naval vessel preceding the *Eisenhower* into Norfolk. Visibility was at least 5 miles and the bridge watch had the *Urduliz* in sight for about 30 minutes before the accident. Thus, the knowledge and the adequacy of the position of the anchored vessel, and visibility were not factors in this accident.

At 0805, the *Eisenhower*'s speed was reduced to 5 knots and about 1 minute later the course was changed from 258T to 229T in the direction along the previous northern edge of the Entrance Reach Channel. The 0810 radar fix indicated that the *Eisenhower* remained on its intended track (229T), the vessel would have continued in the channel and passed clear of the *Urduliz*. However, the direction of the currents, which were about 1.2 to 1.6 knots at 240T to 260T, and the wind, which was about 20 knots from 150T, were setting the *Eisenhower* to the right of its intended track. The conning crew (the navigator, the OOD, and the CO) in discussions during the navigation briefing the day before the accident, had anticipated about a 2-knot flood current in Hampton Roads, greater than the actual current at that time. However, the conning crew did not compensate for the expected current (or the wind) in the Entrance Reach Channel, when they set their course along the northern edge of the channel at 229T. The Safety Board believes that setting a vessel the size of the *Eisenhower* on a course in the confined waters of the Entrance Reach Channel without compensating for the current was a fundamental navigation mistake by the navigator. Because the navigator relied more on plotting than on recognizing the effects of current by visual cues, he should have compensated for the current when setting the vessel's course to track the northern edge of the channel.

At 0811, the navigator recommended that the OOD reduce speed to 3 knots, to arrive at buoy "3" for embarking the docking pilot at 0845. The navigator should have been more concerned about navigating the vessel close to the intended track and avoiding traffic, including the anchored *Urduliz* on the starboard side and the approaching submarine on the port side, than with arriving at the scheduled time at buoy "3." He should have recognized that the track (course made good) would be affected by the current and the wind to a greater amount at the slower speed. The slower speed would have two effects: the amount of movement to the right caused by the current and the wind per unit of time would be increased and the rudders would be less effective. After turning onto 229T, the navigator should have observed closely the progress of the *Eisenhower* by the use of navigation fixes or visual piloting cues and adjusted the course and the speed to compensate for the current and the wind and keep the vessel close to its intended track and away from the *Urduliz*.

However, after the conning crew had been alerted at 0813 by the radar navigation team that the vessel was 25 yards to the right of track and then at 0816 that the vessel was 200 yards to the right of track, immediate action was not taken either by the navigator or by the OOD. Although the visual navigation team was unable to obtain any visual fix from 0807 until 0817, the radar navigation team's vessel position information at 0813 was an alert and the notice at 0816 was corroborative evidence that the vessel had moved to the right of track. This later notice should have caused the navigator to recommend immediately a course change and speed increase to reduce the *Eisenhower*'s set and drift to the right of track and keep it away from the anchored *Urduliz*. Further, neither of the other two members of the conning crew (the OOD and the CO) intervened in time to avoid the collision.

At 0817, the OOD ordered left 10 degrees rudder and informed the CO that the vessel's speed had been reduced to 3 knots. The CO stated that "...10 degree rudder isn't going to get you left very fast" and ordered the OOD to apply additional left rudder and to increase speed to 5 knots. The CO later stated that due to the delay in relaying orders through the OOD and the conning officer, he took over the conning of the *Eisenhower* and ordered left 30 degree rudder to maneuver the *Eisenhower* past the *Urduliz*. The Safety Board believes that had the CO been made aware earlier that the speed of the vessel had been reduced, he may have cancelled the order, or taken the conn, and increased speed to gain greater rudder effectiveness. However, his orders were given at a time when the ramming was imminent.

By ordering an increase in speed to 5 knots and 30 degree rudder commands (left and then right), the CO made the vessel more maneuverable and he was able to first move the bow, and then the stern away from the anchored *Urduliz*. The left 35 degree rudder order was given in an attempt to swing the bow away from the *Urduliz* as much as possible, and the right 30 degree rudder order was given in an attempt to "kick" the stern of the *Eisenhower* away from the *Urduliz* to minimize damage. Despite the CO's orders, the *Eisenhower* struck the bow of the *Urduliz* with its starboard side between aircraft elevators Nos. 1 and 2.

In the 9-minute interval between 0811, when the *Eisenhower* was slowed to 3 knots, and 0820, when it struck the *Urduliz*, the current and the wind moved the *Eisenhower* about 400 yards laterally from its intended trackline course of 229T. A line drawn through the 0820 accident position perpendicular to the *Eisenhower's* intended trackline would intersect the 229T trackline about 1,385 yards from the vessel's 0811 position. This distance reflects the vessel's progress in that direction due to both its average propulsion speed through the water, and current and wind effects. If the *Eisenhower's* speed had been maintained at 5 knots during this period (0811-0820), the vessel would have been moved the same 400 yard distance laterally by the current and the wind, which were fairly uniform in this small area. Its movement in the 229T direction also would have been assisted by components of the current and the wind, and at 0820, would have moved about 1,885 yards in that direction. By trigonometry, it can be shown that at the 5-knot speed, the *Eisenhower* would have cleared the *Urduliz* by about 100 yards. The Safety Board therefore believes that the accident would not have occurred, even though the *Eisenhower* would have passed very close to the *Urduliz*, because it would not have moved as far to the right of track before it cleared the *Urduliz's* anchored position.

When the officer on watch on the *Urduliz* realized that the *Eisenhower* was going to pass close to his vessel, he sent a messenger to notify the master of the situation. After the master arrived on the bridge and assessed the situation, he could have ordered additional anchor chain to be backed out, or backed the engine to move his vessel further away from the channel. Backing out the anchor chain would have taken a few minutes because crewmembers would have to be sent to the bow and then they would have to prepare the anchor gear for release. Backing of the engine to drag the anchor may have taken less time, but such action would have to be taken with care to avoid parting the anchor chain. However, there was no time to accomplish either

option because the collision occurred as the master arrived on the bridge.

The Role of the Conning Crew. -- The Safety Board examined the training, shiphandling experience, and actions of the conning crew of the *Eisenhower*, to determine the factors that led to the ramming of the anchored *Urduliz* at Hampton Roads. The actions of the JOOD or conning officer were not considered a factor in this accident. This was his first conning assignment in Norfolk harbor and he only passed conning orders received from the OOD or the CO. He did not originate any independent orders while entering the harbor nor would he be expected to do so.

The development of the navigator's shiphandling skills occurred during two non-aviation sea duty assignments (totaling about 4 years), which were separated by 8 years of aviation assignments. Under these circumstances, it would have been difficult for the navigator to retain knowledge and skills he developed during his previous shiphandling assignment, and to adapt to the new operational circumstances. The navigator recognized this and before reporting to the *Eisenhower*, made a personal effort to renew and improve the shiphandling skills he had not used for years and to familiarize himself with the Hampton Roads area where he had not previously been stationed. He had supervised the *Eisenhower*'s navigation department for 21 months, and had been responsible for successfully navigating the ship throughout coastal, Latin American, Caribbean, and Mediterranean cruises. However, the Safety Board believes that his training and experience were not sufficient to prepare him fully to pilot this large vessel under the conditions he faced that day in Hampton Roads and this deficiency in his experience contributed to the improper decisions he made that led to the accident.

The navigator set the vessel on a course that had not been adjusted to compensate for the anticipated currents. Further, because he was unfamiliar with the practices of the Port Operations Department and its docking pilots, he did not know that the docking pilots generally arrived 1/2 hour before their assigned duty time and concluded that the arrival of the vessel 4 minutes early was not only unprofessional but could jeopardize preparations for docking the vessel. His recommendation to reduce speed to 3 knots to delay the vessel's arrival at buoy "3" without an accompanying course change worsened the set and drift of the *Eisenhower* putting it on a collision course with the *Urduliz*. However, greater evidence of the deficiencies in his ability to pilot the vessel through the restricted waters was his lack of action to correct the vessel's course when notified by the radar

navigation team at 0816 (after the 0813 alert) that the vessel was deviating, from its, intended course. Because the navigator had only limited recent experience piloting such a large vessel through Hampton Roads, he did not recognize from landmarks or other cues that the *Eisenhower* was setting to the right.

The OOD was the most junior officer and the most inexperienced shiphandler on the conning crew. His assignment as the assistant navigator aboard the *Eisenhower* was his first sea duty assignment, as well as his first shiphandling assignment, having previously served in aviation and administrative assignments. Upon his assignment to the vessel, he completed a basic shiphandling course, became qualified as OOD (underway) in 4 months, and stood watches in that position for 11 months. However, he had not had the opportunity to serve as OOD during a transit of Hampton Roads, and had only observed others acting in that capacity.

In response to the recommendation of the navigator, his superior officer, he ordered the speed reduction, apparently not recognizing the effect it would have on the track of the vessel under the prevailing current and wind conditions. Furthermore, because he apparently did not recognize the significance of the speed reduction, he did not discuss the prudence of the recommendation with the navigator, or make the CO aware immediately of the order he subsequently gave to the JOOD. These omissions may have been the result of insufficient shiphandling experience.

The Safety Board believes that the OOD's basic training and operational experience in shiphandling were insufficient to act as OOD during the navigation of a vessel the size of the *Eisenhower* in the restricted waters of Hampton Roads, and that he should have received greater guidance and supervision from the CO.

The CO had accrued considerable shiphandling experience in several non-aviation sea duty assignments during 7 of the preceding 8 years. He had completed a series of increasingly complex and demanding senior staff and command assignments which had provided him the opportunity to progressively develop shiphandling skills through training courses and operational experience. The CO demonstrated skilled shiphandling abilities on the day of the accident beginning about 3 minutes before the collision, when he became aware that the vessel's speed had been reduced to 3 knots in the prevailing wind and current conditions and assumed the conn in time to avoid more serious damage to his vessel and to the *Urduliz*. The recency, variety, and complexity

of this previous experience made the CO a competent shiphandler, appropriately experienced and qualified for his duties at the time of the accident. However, the Safety Board believes that the CO should have monitored more closely the navigator's recommendations to the OOD, the OOD's conning orders, and the reports of the *Eisenhower's* position along the intended track. The Safety Board believes the CO may have been distracted from his duties of monitoring the conning of the vessel by other activities taking place on the bridge.

Pilotage

During periods of restricted maneuvering, such as when the vessel is within the confines of a harbor, precise movement and control of the vessel is required. At those times, the workload increases dramatically for the visual navigation team on the bridge and for the radar navigation team located in a compartment aft of the bridge. The level of activity on the bridge is considerably greater as communications increase between stations to make certain that the exact position of the vessel is known, and that the vessel follows a safe course.

The visual navigation team, under the supervision of the navigator, must monitor the progress of the vessel by plotting its exact position on the bridge navigation chart at frequent intervals using information communicated to the bridge from visual bearing takers at remote stations. This process allows the navigation team to accurately report the location of the vessel to the conning crew. Each position report establishes the location of the vessel at the time the bearings were taken. Due to reporting and plotting delays, however, the navigation teams report the position of the vessel, relative to the desired track, about a minute after the vessel has actually left that position.

Based on his knowledge of where the vessel was located a minute earlier, the navigator anticipates the changes in rudder and speed necessary to keep it on a predetermined track. However, doing this in restricted waters under rapidly changing conditions is difficult, if not impossible, at times. Under such conditions, it is necessary to compensate for a lack of formal or plotted navigation information by visually observing the changing situation. Markers, buoys, ranges, landmarks, and other prominent objects then serve as an aid to visual plotting or navigating "by eye." Because there were no visual fixes between 0810 and 0817, and the radar fixes were 3 minutes apart, the navigator had to act as a pilot. However, the navigator was not a pilot who routinely navigated through these waters and was not trained to do so.

Without visual or radar fixes, it is difficult to estimate and anticipate the effect of the current and the wind on the movement of the vessel, especially in a setting with which the navigation team is unfamiliar. When piloting visually, the experienced eye uses physical indicators such as the wake or angle of lean of a buoy to estimate the current. The lateral displacement, or set, of the vessel which is being experienced due to the effects of current or wind is often determined by comparing the relative movement of fixed objects. The act of piloting in any restricted waterway is a skill which is developed over time.

During the *Eisenhower's* 6-month deployment, the Entrance Reach Channel had been reduced in width and shifted slightly northward, and buoys had been moved in the Entrance Reach and in the Thimble Shoal Channels. The conning crew was aware of the new buoy locations from the Notice to Mariners and the new positions were plotted on their navigation charts. However, the conning crew on the *Eisenhower* did not have any experience navigating the "new" channel and had not seen Norfolk harbor for 6 months. The Safety Board believes that although the crew's lack of familiarity with the "new" channel did not cause this accident, they would have benefited from a pilot's knowledge and extensive experience in handling large, deep draft vessels in the restricted waters of Hampton Roads. A harbor pilot probably would have recommended against slowing the vessel under the current and wind conditions which existed in the restricted waters of this channel. More importantly, a harbor pilot would have been able to recognize earlier that the vessel was setting to starboard and deviating from the intended track.

Most naval vessels do not utilize the services of pilots, at least in part because they believe that the use of a pilot implies that the crew does not measure up to the navigation task. However, all commercial vessels departing on, or returning from a foreign voyage are required to hire a State pilot, no matter how familiar, or competent, or how many times the master or other deck officers have transited the waterway to or from sea. Even though, a master or deck officer on a U.S. or foreign vessel may have a Coast Guard pilot license for the area, and the vessel is departing on or returning from a foreign voyage, the vessel still is required by state law to use a State pilot. Mariners who have not been in the harbor recently are not aware of changes in channel configurations or of the effects of such changes as is a pilot. A pilot would have the latest local knowledge about the peculiarities of currents, the problems of navigating each channel, local conditions, and movement habits of local vessels.

The CO of the *Eisenhower* stated that he was not aware of any official guidelines for the use of pilots from the U.S. Navy. However, he also stated that a pilot would have had more knowledge of local conditions, including the new harbor configuration, and would have been able to devote full time and attention to the navigation of the vessel.

The Safety Board believes that the use of a pilot was not necessary to avoid this accident. However the Safety Board also believes that a pilot probably would have recognized in a timely manner that the vessel was deviating from its course and taken action in time to avoid the accident.

The use of harbor pilot should be strongly encouraged by higher command. Navy regulations provide a broad statement about pilot use, but do not provide specific guidance as to when they should be used. The Safety Board believes that the Navy should develop more detailed guidelines to provide CO's a basis for deciding when to use pilots. Such guidance should include consideration of changes in harbor configuration, crew experience in transiting the harbor, the length of time since the harbor was last transited, the extent of congestion and restriction of the waterway, and the size of the vessel. Further, this guidance should be provided in a manner that helps to minimize the belief that only crews who do not measure up to the navigation task need to hire a pilot.

Bridge Environment and Crew Coordination

The Safety Board is concerned that the CO did not hear the engine order during critical moments in the navigation of the vessel and was not aware of the speed reduction which had taken place during a time when the CO's attention was focused on other responsibilities. Because of the numerous demands upon the CO, including the many non-navigational duties which existed during the entrance to the harbor, the CO appears to have diverted his attention from the navigation of the vessel.

Because of other design priorities, space on the navigation bridge of an aircraft carrier is, very limited and consequently a large number of stations which affect and are necessary for control of the vessel are located remotely from the bridge. These remote stations, including the radar navigation team, lookouts, the combat information center, primary flight operations, and others, communicate with the navigation bridge using sound-powered

telephones and electronic means, including radio, intercom, and video. Frequent communication between these stations and the bridge is necessary to coordinate the safe movement of the vessel. There were at least 20 crewmembers involved in the navigation and the conning of the vessel into port. In addition, there were 6 to 8 Tigers, the press, and other crewmembers not required to be on the bridge for arrival into port. These additional persons, merely by their presence, may have averted the CO's attention.

The CO did not know, and the Safety Board could not precisely determine, the duty or demands of his position that caused the CO to divert his attention away from his monitoring of the navigation of the vessel and prevented him from hearing the order to the engine order operator to reduce speed. However, the crowded and noisy environment of the aircraft carrier navigation bridge was not conducive to the safe maneuvering of the vessel in the restricted channel. The *Urduliz*, a similar sized civilian vessel, had been piloted to its anchorage with only four persons (pilot, master, mate, and helmsman) on its much larger sized bridge (about 13 feet by 54 feet, plus port and starboard bridge wings measuring about 10 feet by 37 feet), in contrast with more than 20 persons on the much smaller bridge (about 10 feet by 40 feet) of the *Eisenhower*.

Because of the high activity noise, and congestion levels on the bridge of a vessel of this size and complexity, a considerable potential for distraction is perhaps inevitable. But, obviously, to the extent practicable the sources of such distraction should be eliminated. Therefore, the Safety Board believes that the Navy should prohibit all non-essential persons from admittance to the navigation bridge of its vessels when they are being piloted through restricted waterways such as the channels to Hampton Roads.

The Safety Board is concerned also that, on the one hand, the CO did not explicitly direct the watch officers to keep him informed of developments as they occurred and, on the other hand, that neither the OOD nor the navigator took positive action to advise the CO. As a result, although sufficient operational information existed on the bridge to permit a successful transit of the Entrance Reach Channel, the CO did not become aware of it in time to use it effectively. The Safety Board believes that if there had been a more positive exchange of essential operational information among the key members of the bridge navigation team, the casualty almost certainly would have been averted.

The Safety Board believes also that increased emphasis on information exchange and coordination undoubtedly could improve bridge management of other naval vessels and enhance the safety of their navigation. But achieving such performance would require the development of bridge operating procedures and practices specifically designed to facilitate information exchange and crew coordination; it also would require systematic indoctrination of commanding officers and bridge team members in the use of such procedures and practices through specially designed training courses and practice exercises.

Safety Board marine accident investigations frequently have identified shortcomings in bridge management and coordination among masters, the navigation watch, and pilots as contributing factors in marine navigation casualties. As a result, the Safety Board repeatedly has advocated that greater attention be given to this aspect of marine operations. Fortunately, some progress has been made in the maritime community in developing bridge management and teamwork training courses for masters and bridge watch personnel, using bridge simulators, with encouraging results.

The Safety Board is aware also that the Navy has devoted considerable effort and resources to the development and implementation of crew coordination and cockpit resource management training for flight crews of its large aircraft; and it has developed team performance training for its shipboard combat information centers. However, it does not have comparable training programs for its shipboard for its shipboard commanding officers and bridge navigation personnel.

In light of the large number of Naval personnel involved in shiphandling operations, the immense value of the assets involved in the operation of vessels of the U.S. fleet, and the potentially catastrophic consequences of navigation casualties, the Safety Board believes that the Navy should allocate the necessary resources to research, develop, and implement a program of bridge crew management and teamwork training for all vessel commanding officers and bridge navigation personnel.

Waterway

It is difficult for the conning crew of a vessel using the Entrance Reach Channel to determine visually the new northern edge of the channel because there is no navigation aid in the 3.2 miles between buoy "22" on the eastern end of the channel and buoy "2" on the western end of the channel. Even though the anchorage

berths on the northern side of the Entrance Reach Channel have water depths in excess of 50 feet, they should not be considered extensions of the channel width, but rather areas where vessels are expected to be anchored and thus unavailable for maneuvering outside of the channel limits. Proper marking of the northern edge of the channel is more critical because the channel has been narrowed and there is now less width available to maneuver a vessel.

The Safety Board does not agree with the statement by the Coast Guard witness that "... when you put buoys near an anchorage they get run over and serve only as a hazard to navigation." Vessels are expected to safely pass each other in the 1,000-foot-wide channel and, therefore, placing buoys about 1 mile apart along the northern edge of the channel should not interfere with a vessel navigating the channel or entering the anchorages to anchor. Further, if a vessel were to strike a buoy, the damage cost to the buoy and the vessel would be far less expensive than the damage cost resulting from even a minor collision between two vessels. The Coast Guard already uses buoys to mark channels adjacent to anchorages in Norfolk and in other harbors.

Not only would additional buoys on the channel's northern edge provide a channel marking, they could also be used by mariners to visually estimate their vessel's position and how the vessel's course is being affected by wind and current. The presence of additional buoys, for example, 1 mile apart may have provided an earlier indication to the conning crew that the *Eisenhower* was deviating from its intended courses allowing corrective action to be taken earlier, perhaps even in time to avoid the collision. The Safety Board believes that the northern edge of the Entrance Reach Channel should be marked with additional buoys to assist the mariner visually in determining the channel limits and his movement in the channel.

Port Operations Department

If the *Eisenhower* had followed its planned trackline, with its bridge on the northern edge of the previous Entrance Reach channel (700 feet wide at buoy "1ER"), its flight deck would have shadowed or visually blocked out about 590 feet of channel on its port beam, leaving about 110 feet of the channel visible from the navigation bridge to buoy "1ER" and the southern side of the new Entrance Reach Channel. Had the submarine followed a trackline of about 100 to 150 feet to the left of buoy "1ER," the *Eisenhower's* bridge watch may not have been able to see the submarine. The large shadow zone on the port side of the *Eisenhower* prevents a

continuous view of a vessel with a low profile or a small vessel, if it passes too close, especially a vessel such as a submarine.

The Safety Board believes that although the passage of the *Lipscomb* did not contribute to the accident, the Port Operations Department should have coordinated the departure time of the *Lipscomb* so that it would not have been in the Entrance Reach Channel at the same time as the *Eisenhower*. The Safety Board also believes that the Port Operations Department should control naval vessel traffic so that deep draft naval vessels (vessels with a draft of 25 feet or more) do not encounter another deep draft naval vessel when transiting the Entrance Reach Channel.

Regulated Navigation Area, Elizabeth River, Norfolk, Virginia

After an aircraft carrier is in the Entrance Reach Channel, and shortly before it arrives at buoy "3," it must slow down as much as possible, and still maintain steering control, to embark a docking pilot. The docking pilot attempts to board the vessel at or before reaching buoy "3." After he boards and after tugs are positioned, the vessel is maneuvered into its berth. This operation normally takes about 45 minutes and the channel is effectively blocked during this period inhibiting other vessel transits. Also during this period, the vessel is operating at a very low speed and is greatly hampered in its ability to maneuver, thus posing a hazard both to itself and other vessels in the narrow channel. Even if an aircraft carrier or other large naval vessel pivots only partially in the channel, there is no room available for a vessel to pass safely within the Entrance Reach Channel. The 1,000-foot width of the channel is narrower than the length of most aircraft carriers and only about 100 feet wider than battleships are long. The anchorage area north of the Entrance Reach Channel may not always be void of vessels to allow for vessels to move outside the channel and past a vessel maneuvering into its berth at the Naval Station. The Safety Board believes that the amount of channel available to another vessel in the Entrance Reach Channel, when a large naval vessel is maneuvering into a berth at the Naval Station, is too narrow for safe navigation. There is insufficient room to maneuver to avoid another vessel due to bad weather, or for a steering or other casualty. To avoid maneuvering difficulties with other marine traffic and as an added measure of safety, the Safety Board believes that the Navy should request the Coast Guard to expand the RNA (prescribed for moving aircraft carriers and other large naval vessels to, or from, the Norfolk Naval Shipyard) to include the Entrance Reach Channel.

Toxicological Testing of Navigation Personnel

Toxicological specimens were not obtained from the conning crew or the navigation teams, or any other person aboard the *Eisenhower*, following the accident. Post-accident toxicological testing was not required by Navy regulation, and as a result, neither the conning crew nor the navigation teams of the *Eisenhower* were requested to provide samples, precluding such testing. However, there was no evidence discovered during the course of the investigation to suggest that the conning crew was medically unfit, fatigued, or under the influence of alcohol or other drugs at the time of the accident.

In its accident investigations, the Safety Board routinely examines the toxicological aspects of accident causation, and it believes that the Navy should do so during its accident investigations as well, and that it should obtain and examine toxicological specimens from any crewmember whose activities could be associated with the circumstances of the occurrence. By requiring such testing following all accidents involving Navy vessels, especially those which involve civilian vessels, the Navy would enhance the safety of its operations, its personnel, and other seafarers. Accordingly, the Safety Board reiterates Safety Recommendation M-88-38.

Marine Accident Information Dissemination

The Safety Board interviewed numerous U.S. Navy personnel, formally and informally, in the course of its investigation. Many of the personnel interviewed had little or no relevant information and were extremely curious about the facts of this accident. They requested information about the accident so that they might learn from the experiences of the crew of the *Eisenhower*.

The Navy has a periodic publication, FATHOM, which includes information concerning accidents involving its vessels, similar to a publication associated with its aviation accident advisory program. Notwithstanding this publication, COs, navigation department personnel, and deck watchstanders, report that they are rarely exposed to detailed information as a result of the investigations which examine vessel maneuvering accidents in the fleet. These persons could use the knowledge learned from the details of vessel accident investigations and analysis to operate their vessels more safely and avoid accidents. However, the FATHOM is distributed to many agencies who may not need such information and the Navy may not deem it appropriate to include

the in-depth information that could benefit its navigation personnel in the FATHOM.

Thus, the Safety Board believes that the Navy, in an effort to inform its personnel and prevent accidents involving its vessels, should establish an internal comprehensive marine accident information newsletter or similar publication to disseminate to its personnel in command, navigation, and other shiphandling assignments, reports of collisions and groundings, and related accident prevention information. Further, the Safety Board believes that the Navy should provide to commanding officers and navigation departments of its aircraft carriers copies of the Safety Board's *Eisenhower* accident report.

FOOTNOTES

¹The term the Navy uses to describe distinguished civilian guests of the Navy and male civilian family members of the crew who board a Navy ship returning from deployment. It is a morale enhancement activity for family members so they may see how the ship operates and what their sponsor does, and where he works.

²To control or direct the movement of a ship by rudder and engine orders.

³Senior enlisted man in the navigation department.

⁴This navigation team was located in the TOP radar darkroom compartment aft of the after bulkhead on the bridge.

⁵The engine order operator who passes engine orders to the engine rooms.

⁶Polmar, Norman, "The Ships and Aircraft of the U.S. Fleet" (14th Edition), Naval Institute Press, Annapolis, Maryland, 1987, pp 82-83.

⁷A senior officer qualified to assume the operational direction of the vessel. On the *Eisenhower*, the navigator qualified the officer as CDO and the CO approved the qualification with a letter which was placed in the officer's service record.

⁸Polmar, page 11.

⁹Approximate elevation of one's eye above the waterline.

¹⁰Tidal Current Tables, 1988, for the Atlantic Coast of North America. Published by the National Ocean Service, National Oceanic and Atmospheric Administration of the Department of Commerce.

¹¹Marine Accident Report. -- "Collision between USS *Richard L. Page* (FFG-5) and the U.S. Fishing Vessel *Chickadee* in the Atlantic Ocean on April 21, 1987" (NTSB/MAR-88/04).

CONCLUSIONS

Findings

1. The intended trackline of the *Eisenhower* was appropriate for a vessel of its size and the width of the channel.
2. Had the navigator and officer of the deck observed closely the vessel's movement after the reduction of the vessel's speed, they would have been able to detect the *Eisenhower*'s movement to the right of track and taken corrective action.
3. The navigator recommended, and the officer of the deck ordered, a reduction in the vessel's speed to a level at which the current and the wind greatly affected the vessel's movement to the right of the intended track and decreased the effectiveness of the rudders.
4. The previous piloting training and experience of the navigator and the officer of the deck did not prepare them sufficiently to pilot a vessel the size of the *Eisenhower* through the restricted and unfamiliar channels of Hampton Roads.
5. The commanding officer was not informed in a timely manner by the navigator or the officer of the deck that the vessel's speed had been reduced.
6. The commanding officer did not hear the speed reduction ordered by the officer of the deck or the conning officer's order to the lee helm because his attention may have been diverted from the vessel's navigation by other duties.
7. Although the commanding officer recognized the hazard associated with the speed reduction when informed of it by the officer of the deck, the commanding officer's actions came too late in the accident sequence to prevent the ramming.
8. The commanding officer used his shiphandling experience to avoid a more serious ramming.
9. Commanding officers of naval vessels need more specific

guidance on the use of pilots than that provided for in U.S. Navy regulations.

10. The use of a pilot would have compensated for the inexperience in piloting of the navigator and the officer of the deck, and probably would have prevented the accident.
11. The Port Operations Department scheduled the submarine's movement so that it was in the Entrance Reach Channel when the *Eisenhower* was scheduled to be in the channel, restricting the maneuvering room available to the *Eisenhower*.
12. The *Urduliz* was properly anchored in berth "Z" in anchorage "A" which was within the new anchorage boundaries and outside of the new channel edge and did not contribute to this accident.
13. Additional buoys on the northern limits of the Entrance Reach Channel would have assisted in clearly delineating the northern edge of the channel limits.
14. Permitting other vessels to operate in the vicinity of aircraft carriers and other large naval vessels transiting the Entrance Reach Channel significantly reduces the space for maneuvering such large naval vessels in the Channel.
15. The presence of non-essential persons on the navigation bridge of naval vessels while maneuvering in restricted waters may cause conning crews to be distracted from their operational duties.
16. Bridge management and team coordination principles are not adequately emphasized in the training of shipboard commanding officers and bridge navigation personnel on Navy vessels.
17. The establishment by the Navy of an internal marine accident advisory publication to provide vessel accident reports and other accident prevention information to commanding officers, navigators, and other personnel in shiphandling assignments would improve safety in the fleet.

Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the delayed and insufficient action to correct the *Eisenhower's* deviation from the intended track by the navigator and the officer of the deck because of inexperience in piloting the vessel through the restricted channel in Hampton Roads; the selection by the navigator of a course through the Entrance Reach Channel that did not compensate for the current and the wind; and the inadequate monitoring of the navigation of the vessel by the commanding officer. Contributing to the accident was the navigator's order to reduce the speed from 5 knots to 3 knots in an attempt to reach buoy "3" at a prescribed time and the inadequate guidance by the U.S. Navy on the use of pilots on large vessels.

RECOMMENDATIONS

As result of its investigation, the National Transportation Safety Board made the following recommendations:

-- To the U.S. Navy:

Provide in an appropriate U.S. Navy directive, guidance and requirements to commanding officers of vessels about the use of Federal or State pilots; consider such areas as changing harbor configurations, the crew's experience in transiting the harbor, the length of time since the harbor was last transited, the extent of congestion or restriction of the waterway, and the size of vessel.
(Class II, Priority Action) (M-90-1)

Develop and implement a program of bridge crew management and teamwork training for shipboard commanding officers, navigators, and other bridge navigation personnel.
(Class II, Priority Action) (M-90-2)

Establish a policy which excludes non-essential persons from the navigation bridge of U.S. Navy vessels maneuvering in restricted waters.
(Class II, Priority Action) (M-90-3)

Require the Norfolk Naval Station to schedule and control naval traffic departing or arriving at Norfolk so that no deep draft naval vessels meet in the Entrance Reach Channel.
(Class II, Priority Action) (M-90-4)

Request the Coast Guard to extend the Regulated Navigation Area at Title 33 Code of Federal Regulations Paragraph 165.501(d)(11) in Norfolk harbor to include the Entrance Reach Channel for aircraft carriers and other large naval vessels.
(Class II, Priority Action) (M-90-5)

Establish and publish an internal newsletter or other publication that provides comprehensive vessel accident information, including U.S. Navy vessel accident reports and related accident prevention information, and disseminate it to personnel in command, navigation, and other shiphandling billets.

(Class II, Priority Action) (M-90-6)

Disseminate this accident report to commanding officers and navigation department personnel of all aircraft carriers in fleet.

(Class II, Priority Action) (M-90-7)

-- To the U.S. Coast Guard:

Establish additional buoys on the northern side of the Entrance Reach Channel to delineate the channel limits.

(Class II, Priority Action) (M-90-8)

Also, the Safety Board reiterated the following safety recommendation to the U.S. Navy:

M-88-38

Amend OPNAVINST 5350.4 (Substance Abuse Prevention and Control) to require drug testing of U.S. Navy personnel directly involved in an accident with a U.S. civilian vessel in international waters or any civilian vessel in U.S. waters.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Acting Chairman

/s/ Jim Burnett
Member

/s/ John K. Lauber
Member

/s/ Lemoine V. Dickinson, Jr.
Member

January 3, 1990

INVESTIGATION

The National Transportation Safety Board was notified of this accident about 2 hours after it occurred on August 29, 1988. Because the accident involved a U.S. Navy (public) vessel and a commercial (non-public) vessel in U.S. waters, the Safety Board and the U.S. Coast Guard agreed pursuant to the Memorandum of Understanding between the two agencies, dated September 28, 1981, that it would be in the public interest for the Safety Board to conduct the investigation with Coast Guard participation.

Safety Board investigators were dispatched on August 29, 1988, to Norfolk, Virginia, the homeport of the naval vessel and the location of the moored commercial vessel.

Sworn testimony was taken in accordance with the authority granted to the Safety Board by Section 304(b) of the Independent Safety Board Act of 1974, from three crewmembers of the Spanish Bulk Carrier *Urduliz* on September 2, 1988, and from seven crewmembers of the USS *Dwight D. Eisenhower* (CVN 69) on September 14, 1988. Testimony was also taken from the Navy docking pilot on the *Eisenhower*, the harbor pilot on the *Urduliz*, and from the Chief of the Planning and Waterways Management Section of the Aids to Navigation Branch, Fifth Coast Guard District, on September 15, 1988. Parties to the investigation were: The owner of the *Urduliz*; the U.S. Navy, the operator of the *Eisenhower*; and the U.S. Coast Guard.

PERSONNEL INFORMATION

Captain Gary L. Beck, USN

Captain Gary L. Beck, 51, CO of the *Eisenhower*, was commissioned through the Aviation Officer Candidate Program in 1960, earned his "wings" in 1961, and was assigned as a naval aviator to various aircraft attack squadrons, including several assignments aboard aircraft carriers. In these assignments, he served as a pilot, line officer, instructor, operations officer, executive officer (XO), and commanding officer (CO) until 1979. During this period of service as an aviator, Captain Beck graduated from the U.S. Naval Postgraduate School with a Master of Science Degree in Aeronautical Engineering. He also graduated from the Navy's Test Pilot School and served as a test pilot.

In 1979, Captain Beck's career development progressed to non-aviation duties. He took graduate level nuclear engineering courses, and qualified as shipboard engineering officer of the watch. He completed training in the operation of naval nuclear propulsion plants and Navy Leadership Management Education training, which are provided to prospective COs and XOs prior to assignment to nuclear-powered vessels. He was subsequently assigned as operations officer aboard the USS *Carl Vinson* (CVN 70), a newly constructed nuclear-powered aircraft carrier which was being-prepared for commissioning. The *Vinson* was commissioned in 1982, and Captain Beck was assigned as XO; he qualified as command duty officer (underway) and as a conning officer during replenishment at sea operations.

He was selected for a major afloat command as CO of the USS *Niagara Falls* (AFS 31), a deep draft combat stores and underway replenishment ship. En route to that assignment Captain Beck attended various Navy training courses, including a two-day practical shiphandling course, a four-day course in navigation rules of the road, and five days of ship control simulator training. He attended the Surface Warfare Prospective CO Course, and assumed command of the USS *Niagara Falls* in June 1984. He completed this assignment in June 1986.

Captain Beck was selected for command of the *Eisenhower* and assumed command in October 1986. The *Eisenhower* completed overhaul and was brought to readiness for fleet operations in 1987, following coastal, Latin American, and Caribbean operations.

Captain Beck's professional accomplishments and career highlights include deployment during the Cuban Missile Blockade in

1964, two combat deployments to Southeast Asia in 1968 and 1969, during which he completed 140 combat missions, and service as a test pilot at the Naval Air Test Center. His awards include 14 Air Medals, Navy Commendation Medal, Presidential Unit Citation, Navy Unit Commendation, Armed Forces Expeditionary Medal, Vietnamese Gallantry Cross, and the Navy Achievement Medal.

Commander Peter N. Maxwell, USN

Commander Peter N. Maxwell, 42, navigator of the *Eisenhower*, was commissioned through the Aviation Officer Candidate Program in 1969, earned his "wings" in 1970, and was assigned to land based aviation antisubmarine warfare (ASW) patrol squadrons. He served as navigation officer, line division officer, plans and programs officer, and pilot until 1976. In 1976, CDR Maxwell completed the OOD (basic) training course and the Fundamentals of Marine Navigation course prior to his initial shipboard assignment as assistant navigator aboard the aircraft carrier MIDWAY (CV 41). CDR Maxwell remained in this assignment until January 1979, during which time he became qualified as an OOD (underway). He completed the prescribed course of instruction at the Armed Forces Staff College in 1979, prior to being assigned to a series of ASW patrol squadrons for 4 years. During these assignments, he served as pilot, pilot instructor, retention officer, training officer, command management director, and operations officer. Between 1983 and 1985, CDR Maxwell served in Washington, D.C., as the assistant for Shore and Sea Based ASW Plans and Program's, and in 1985, he completed training which led to C-130 aircraft certification and assignment as CO of a fleet support squadron through 1986. He was assigned as navigation officer of the *Eisenhower* in November 1986.

CDR Maxwell's professional accomplishments and career highlights include combat service as a patrol plane commander in Southeast Asia during 1971 and 1972, for which he received an Air Medal. His awards also include the Navy Commendation Medal and a Meritorious Service Medal.

Lieutenant John A. Sullivan, USN

Lieutenant John A. Sullivan, 32, assistant navigator and OOD on the *Eisenhower*, was commissioned through the Reserve Officer's Training Corps program in 1978 and was designated a naval flight officer in 1981, upon completion of Advanced Navigator Training. LT Sullivan was assigned to various land based ASW patrol squadrons between 1981 and 1985, and served as personnel officer, safety officer, training plans officer, assistant operations officer, and patrol plane navigator and mission commander.

Between 1985 and 1987, he was assigned as Flag Lieutenant to the Commander, Naval Space Command. Upon his assignment to the *Eisenhower*, LT Sullivan completed a 5-day practical shiphandling course. He is the recipient of the Navy Achievement Medal.

Master Juan Luis Plaza-Gavicagogeascoa

Captain Plaza-Gavicagogeascoa, 52, master of the *Urduliz*, had been going to sea for 34 years and had held a merchant marine master's license from the Spanish government for 26 years. He had worked for the owners of the *Urduliz* for 24 years and had been master of several of their vessels for 15 years. He had been the master of the *Urduliz* for 2-1/2 months, the length of time that the present owners had owned the vessel.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

APPENDIX A

LABORATORY: 1

HOURS: .5

TITLE: Chart Reading (Scavenger Hunt)

Reference: Lesson Number 3

I. Learning Objectives

- A. The student will know and comprehend the use of hazard and depth symbology used on charts.
- B. The student will apply correct procedures to become proficient in basic plotting techniques.

II. Instructional Aids

- A. Chart Number 1 (Appendix G in Hobbs)
- B. DMAHC chart 12221 (or substitute)
- C. Plotting instruments

III. Instructor Preparation

- A. Identify numerous symbols found on the chart.
- B. List the latitude and longitude only for each symbol.
- C. Lab 1 on page A-2 is provided as a sample.

IV. Presentation

- A. Distribute charts and the list of latitudes and longitudes.
- B. Have students identify the symbol at each location.
- C. Ask questions pertinent to the individual symbols.

SAMPLE

LAB 1 Chart Reading

Name: _____

Chart 12221

1. USING THE CHART PROVIDED, FIND THE FOLLOWING INFORMATION:
(6 POINTS)

- A. CHART SCALE:
- B. SOUNDINGS RECORDED IN:
- C. DATE PRODUCED AND EDITION:
- D. CHART NUMBER:
- E. WHO PRODUCED THE CHART:
- F. SOUNDING DATUM:

2. Given the following Lat. and Long, identify object.

37° 19.9' N
076° 00.9' W

3. a. Plot a point at the given Lat. and Long

37° 14.0' N
076° 11.5' W

- b. What is the depth of water at this point?

4. What is symbolized at 37° 18.3' N, 076° 10.4' W?

5. What are the coordinates of the abandoned lighthouse at Cape Henry?

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 2

HOURS: .5

TITLE: Chart Reading

Reference: Lesson Number 3

I. Learning Objectives

- A. The student will know and comprehend hazard and depth symbology used on charts.
- B. The student will apply correct procedures to become proficient in basic plotting.

II. Instructional Aids

- A. Chart Number 1 (Appendix D in Hobbs)
- B. DMAHC chart 12221 (or substitute)
- C. Plotting instruments

III. Instructor Preparation: None

IV. Presentation

- A. Divide students into two-person teams.
- B. Each team generates a list of latitudes and longitudes corresponding to special symbols on the chart.
- C. Halfway through the laboratory period, the teams exchange lists of latitudes and longitudes and attempt to identify the symbol at each location. The teams should be able to identify the purpose of the symbol and whether or not it presents a hazard to navigation.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 3

HOURS: 1

TITLE: Lights

Reference: Lesson Number 4

I. Learning Objectives

- A. The student will know light characteristics.
- B. The student will apply correct procedures to become proficient in the use of the Light List.
- C. The student will apply correct procedures in computing the visibility of a navigation light.

II. Instructional Aids

- A. Excerpts from Light List, including the luminous range diagram
- B. Chart corresponding to above excerpt
- C. Plotting instruments
- D. Sample Lab 3 and Computed Visibility Form

III. Instructor Preparation

- A. Select various lights from the chart.
- B. Make excerpts for each student corresponding to the above lights from the Light List.
- C. Develop a scenario for a problem including height of eye and meteorological visibility.

IV. Presentation

- A. Distribute chart and Light List excerpts.
- B. Have students identify phase characteristics for each light.

- C. Have students solve for computed and luminous range and computed visibility.
- D. Have students locate the light on the chart and plot the computed visibility.

SAMPLE

LAB 3

Lights

Name(s) _____
Use Chart #12221

1. What are the light characteristics of the Cape Henry Abandoned Lighthouse?

2. a. What are the characteristics of the buoy M12 in the Mobjack Bay channel?
 b. What does the buoy indicate?
 c. What are its coordinates (Lat, Long)?

3. What are the light characteristics of the light located at $37^{\circ} 15.7' \text{ N}$, $076^{\circ} 20.0' \text{ W}$?

4. What are the light characteristics of the Old Point Comfort light at the channel entrance to Hampton Roads?

5. Using the Computed Visibility Form provided, calculate the computed visibility of Chesapeake Light. Assume meteorological visibility is 11 NM and your height of eye is 50 feet.

6. If your ship were to enter Hampton Roads, what chart would you use?

Light's Name: _____

Luminous Range:

Nominal Range (from Light List): _____NM

Meteorological Visibility (Given): _____NM

Luminous Range (from Diagram): _____NM

Computed Range:

HT of Light (from Light List): _____FT

HT of Eye (Given): _____FT

Geographic Range of Light: _____NM

Horizon Distance of Observer's Eye: _____NM

Computed Range: _____NM

Computed Visibility:

Luminous Range: _____NM

Computed Range: _____NM

Computed Visibility: _____NM

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 4

HOURS: 1

TITLE: Plotting Exercise (Gyroland)

Reference: Lesson Numbers 6, 7, and 8

- I. Learning Objective: The student will apply correct procedures in improving plotting proficiency, particularly the plotting of Running Fixes.
- II. Instructional Aids
 - A. Gyroland chart and script or Sample Lab 4
 - B. Plotting instruments
 - C. Chart 12270
- III. Instructor Preparation: Make copies of Gyroland script (attached) or Sample Lab 4 (attached).
- IV. Presentation
 - A. Distribute Gyroland chart and script or Sample Lab 4.
 - B. Students follow the script in plotting the exercise.

GYROLAND SCRIPT

1. At 0800, you obtain an accurate fix at 39-00N/075-12W. You are proceeding on course 090°T at 10 KTS entering a fog bank (plot and label).
2. At 0809, the fog thins, and you observe a light at 160°T and determine it to be "R. FIX LIGHT." Then the fog thickens once again (plot and label LOP & DR).
3. At 0830, you happen to once again sight "R. FIX LIGHT" bearing 240°T (plot and label LOP, DR posit, advance 0809-0830 LOP parallel to line connecting 0809 DR posit and 0830 DR posit, R-Fix posit and new DR vector).
4. At 0840, you change course to 025°T (plot/label DR & vector).
5. At 0855, you obtain a radar range of 5,000 yds to light "C" (plot and label distance LOP and DR posit).
6. At 0905, you change course to 330°T and change speed to 15 KTS (ensure 0900 DR posit is plotted and labeled; plot and label 0905 DR posit and new DR vector).
7. At 0923, you catch a visual bearing LOP on "Pt A" Light of 050°T.
 - a. Measure the straight-line distance from 0855 DR posit to 0923 DR posit.
 - b. Place parallel rulers on 0855 and 0923 DR posits and advance it to Light.
 - c. Using dividers, set for distance determined in Step "a" above. Now apply same distance from Light "C" to a new, transposed position for Light "C" (roughly between buoys "1" and "2" in channel) and draw advanced range arc.
8. Plot and label 0855-0923 advanced distance LOP and R-Fix.

NOTE that two DISTANCE LOPs can also be used to obtain a Running Fix.

NOTE also that the number of course or speed changes made between the two LOP DR positions are of no consequence.

DO NOT USE A RUNNING FIX IF THE TIME BETWEEN LOPs EXCEEDS 30 MINUTES. They become too unreliable.

SAMPLE

LAB 4 LOP/DR/R-FIX

Answer Sheet /15
Chartwork /10

Name _____
Use Chart #12270

Put your name on chart. You must turn in the completed chart.

Plot the following points:

- A. L 38 49' 10" N 076 21' 06" W
B. L 38 48' 27" N 076 22' 06" W
C. L 38 48' 37" N 076 25' 51" W

You are onboard the USS Mitscher (DDG-57) serving as navigator. Lay down our track from Pt A to Pt B to Pt C. Be sure to include TR, leave SOA blank for the time being. We depart Pt A at 0000 for Pt B

1. What is our first course and distance along the track (from Pt A to Pt B)?

Course _____ Distance _____

2. To arrive at Pt B at 0006, what speed is required (SOA)?

SOA _____ (Assume this speed is now our speed)

3. At 0003 we cut a fix on the following bearings:

Bloody Pt. Bar Light	309
Poplar Harbor Chimney	191
Wades Pt Radio Tower	081

Are we on track? Yes No (Circle one)

Are we on time? Yes No

4. What type of buoy lies off our port quarter?

5. At 0006, we cut a fix. (2 visuals, 1 radar)

Bloody Pt. Bar Lt.	323
Poplar Harbor Chimney	184
North Tip Poplar Is.	4400 yards

Did we arrive on time? Yes No

6. At 0006, we change speed to 20 kts. What is Course and Distance to Pt. C?

Course _____ Distance _____

7. What is our expected arrival time at Pt. C?

Time _____ (remember to round off)

8. Fog sets in, but we still can see Bloody Pt Bar Lt. Lay the following LOPs:

0009	356	3050 yds
0012	031	3400 yds

Label the EP's for times 0009 and 0012.

9. At time 0015, you lose Bloody Pt Bar light visually and on radar. You lay a range LOP to Poplar Is. North Tip at a range of 6800 yds. Lay a Running Fix for time 0015, using the LOP at time 0012.

Does our fix show us exactly at Pt. C? Yes No

10. The CO asks you, "Is Poplar Island Narrows navigable?"
(Ship's Draft 15 is feet)

Yes No

11. From Pt. C, we turn to CSE 006. How far is this course good? What keeps us from going any further on the 006 leg?

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 5

HOURS: 1.5

TITLE: Practical Plotting Exercise

Reference: Lesson Number 12

- I. Learning Objective: The student will apply correct procedures for basic plotting techniques used in piloting in a timed exercise.
- II. References and Texts: None
- III. Instructional Aids
 - A. Plotting exercise scenario and script (attached)
 - B. DMAHTC 12254
 - C. Plotting instruments
 - D. Audiocassette player and prerecorded cassette (Optional)
 - E. The NAVSIM computer software may be programmed by the instructor for this exercise.
- IV. Instructor Preparation
 - A. Review plotting exercise.
 - B. Make copies of exercise (attached).
 - C. Record script onto an audiocassette in proper time sequence (optional).
- V. Presentation
 - A. Distribute scenarios and charts.
 - B. Students can work in pairs or independently in accordance with the exercise scenario.
 - C. Present the scenario.

- D. Present the script, either by reading or playing recorded cassette.

PRACTICAL EXERCISE - PILOTING LAB

SITUATION: You are the navigator on board USS *OAK HILL* (LSD 51) returning from deployment and are proceeding up the Thimble Shoal (main ship) Channel enroute to Little Creek AMPHIBIOUS ANCH LE-J4, to offload equipment prior to entering port.

KNOWN DATA: Length of your ship 522', dist from bridge (pelorus) to the hawespipe 150', standard rudder 15° (for tactical data, refer to page 240 in Marine Navigation).
Piloting chart to be used -- NR 12254, GYRO ERROR ~0°.

INSTRUCTIONS: Work in pairs -- one plotting, one bearing recorder (visual bearing will be given every three (3) minutes via tape recorder); bearing log will be provided. If you miss a bearing, don't stop. Continue with exercise. Maintain your DR.

- a. The bearing recorder will record bearings in the bearing log.
- b. The plotter will fix ship position using bearings provided from bearing.
- c. When told to stop, exchange jobs.

PART I

SECT 1: Lay out your PIM(track) as stated below.

- a. L 36°57'24"N
 076°22'47"W
 TR-288°T
 SOA 12 KTS
- b. L 36°59'09"N
 076°09'25"W
 TR-211°T
 SOA 8 KTS
- c. L 36°58'03"N
 076°10'17"W
 TR-158°T
 SOA 6 KTS

Time 0800

Anticipate 0 set and drift.

SECT 2: Figure your advance and transfer for each turn.

Turn #1 advance _____ transfer_____

Turn #2 advance _____ transfer_____

PART II: Start exercise. Listen carefully to each set of bearings provided. (Bearings will be given at three-minute intervals). GOOD LUCK!

- a. Figure set and drift.
- b. Exchange places.
- c. Figure set and drift.

PART III: Proceed to anchorage. Anticipate letting go bearing off Little Creek Jetty Light.

PART IV: Figure course to proceed to vicinity of Buoy "LC" to pick up pilot.

Cse _____

Dist _____

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 6

HOURS: 1

TITLE: Maneuvering Board Fundamentals

Reference: Lesson Number 23

I. Learning Objectives

- A. The student will comprehend the theory of relative motion.
- B. The student will comprehend "bearing drift" and apply the concept in determining relative motion.
- C. The student will know the correct terminology associated with the speed triangle and the relative plot.
- D. The student will know the use of the 3-minute rule.

II. References and Texts

- A. Instructor references
 - 1. Radar Navigation Manual and Maneuvering Board Manual, Publication 1310
 - 2. Maneuvering Board Workbook, NAVPERS 93440-A, pp. 1-1 through 4-6
- B. Student text: Maneuvering Board Workbook, NAVPERS 93440-A, pp. 1-1 through 4-6

III. Instructional Aids

- A. Training Device 6605-00-240-05717: Wall-mounted maneuvering board
- B. Large parallel rulers (chalkboard)
- C. Large dividers 18" (chalkboard)
- D. PowerPoint slide or transparency of maneuvering board

- E. Computer/projection system or overhead projector
- F. Chalkboard/whiteboard
- G. Video: Relative Motion and the Maneuvering Board, 24177DN, 12 min. (optional)
- H. VCR/Monitor (optional)

IV. Suggested Methods and Procedures

- A. Problems 2.1 through 2.21 in the student workbook illustrate elementary plotting techniques; problem 2.6 reinforces the discussion of cardinal and intercardinal points.
- B. Problems 2.22 through 2.25 expand on the topic of the relative plot by introducing the concept of passing ahead or astern. These problems cover the relationship between ownship's course and the relative motion problem and provide good examples for explaining "bearing drift."
- C. Problems 3.1 through 3.4 present examples of basic plotting; problems 3.5 through 3.10 are basic CPA problems. (Note: CPA is covered more thoroughly in Lesson 2 of this guide.)
- D. The following problems are recommended for homework and discussion during lab: 2.1, 2.3, 2.6, 2.8, 2.13, 2.15, 2.22, 2.23, 2.25, 3.3, 3.6, and 3.10.
- E. Introduce the terminology and abbreviations contained in the Maneuvering Board Manual glossary.
- F. Review the list of maneuvering board techniques (workbook, pp. 1-3).
- G. Review the list of maneuvering board work habits (workbook, pp. 3-10).
- H. Problems 4.1 through 4.5 in the Maneuvering Board Workbook are good practice for basic speed triangle construction and labeling techniques.

**NAVAL RESERVE OFFICERS TRAINING CORPS
NAVIGATION**

LABORATORY: 7

HOURS: 1

TITLE: Maneuvering Board Fundamentals

Reference: Lesson Number 24

I. Learning Objectives

- A. The student will apply the relative plot and the speed triangle to determine the closest point of approach (CPA), the time of CPA, and the true course and speed of the maneuvering ship using the maneuvering board.
- B. The student will apply procedures used to solve the maneuvering board speed triangle in practical problems in order to increase proficiency.

II. References and Texts

- A. Instructor references
 - 1. Radar Navigation Manual and Maneuvering Board Manual, Publication 1310
 - 2. Maneuvering Board Workbook, NAVPERS 93440-A
- B. Student text: Maneuvering Board Workbook, NAVPERS 93440-A, pp. 5-1 through 8-1.

III. Instructional Aids

- A. Training Device 6605-00-240-5717: Wall-mounted maneuvering board
- B. Large parallel rulers (chalkboard)
- C. Large dividers 18" (chalkboard)
- D. PowerPoint slide or transparency of maneuvering board sheet
- E. Computer/projection system or overhead projector

F. Chalkboard/whiteboard

IV. Suggested Methods and Procedures

- A. Problems 5.1 through 5.8 are basic tracking problems.
- B. Problems 5.9, 5.11, and 5.13 cover passing ahead or astern along with finding CPA.
- C. Problems 5.12 through 5.14 introduce the additional work required if either reference or maneuvering ship alters course or speed.
- D. Problems 6.1 through 6.3 are basic required course and speed problems.
- E. Problems 6.4 through 6.9 are higher level stationing problems; good for discussion.
- F. Problem 6.10 is an ideal review problem.
- G. All problems in Chapter 7 reinforce the relationship between relative motion and the speed triangle. These are advanced stationing problems.
- H. All problems in Chapter 8 reinforce the relationship between relative motion and the speed triangle by requiring students to solve for multiple stations.
- I. All problems in Chapter 11 provide practice in maneuvering no closer than a specified distance or through a particular point.
- J. The following problems are recommended for homework and discussion during lab: 5.3, 5.5, 5.8, 5.9, 5.10, 5.13, 6.2, 6.4, 6.12, 7.3, 7.7, and 8.8.

APPENDIX B

The *USS GONZALEZ* (DDG 66) Grounding

The *USS GONZALEZ* (DDG 66) is the 16th ship of the newest Arleigh Burke class destroyer. Outfitted with the state of the art AEGIS SPY1-D radar system, she is, in November 1996, the newest warship in the U.S. Navy.

After completing the initial portions of her Combat Systems Qualification Testing (CSQT) Type Training in the Puerto Rican Operation Area, *USS GONZALEZ* anchors for the first time on 8 November 1996 near Philipsburg, St. Maarten, N.A. for a liberty port. She is scheduled to get underway on Tuesday, November 12, 1996 at 0745. As is typical for most surface combatants that anchor out, arrangements are made for a CHT barge to moor on the port side, to accommodate *GONZALEZ*'s sanitary tank discharge.

On 11 November, the day prior to the scheduled underway, a navigation brief is held for all key personnel to be involved in the upcoming Sea and Anchor Detail. The Senior Watch Officer (SWO) modifies the original watchbill, approved by the Commanding Officer (CO) nearly a month prior, on the morning of the 11th. Changes are necessary because, although posted on the Plan of the Day, several personnel are absent for the brief. Some of the key personnel are the Piloting Officer, the Engineering Officer of the Watch (EOOW), the Starboard Bearing Taker, the Shipping Officer Under Instruction (U/I), the CIC Plotter, the CIC Scope Operator, the Fathometer Watch, and the Chief Boatswain. Replacements are obtained from readily available personnel. Subsequent to the brief, the Navigator (NAV) modifies the watchbill without consent of the CO, Executive Officer (XO), or SWO. These watchbill modifications all involve navigation personnel, the most significant of which involved the scheduled Bearing Recorder acting as Bridge Nav Plotter U/I and the scheduled Piloting Officer, a Lieutenant (LT), directing an OSC to replace him as the actual Piloting Officer. The OSC did not attend the navigation brief.

The brief was administered by the NAV. The following was covered:

1. Navigation Team/Station Assignments
2. Navigation Equipment Status: The GPS, WRN-6, Fathometer, Pitlog, SPA-25G, SPS-64, SPS-67, INTIPS, the gyrorepeaters and the wind indicators are all given an "UP" status.
3. Chart Information: 25613 was compared on 11 NOV 96.
 - a. Danger Bearings/Ranges – NGT 101 on "B"
 - b. Danger Soundings – Depths to 36 feet outlined in blue.
 - c. Shallowest Depth along track – No depths shallower than 36 feet.
4. Outbound St. Maarten underway: 0745 +4Q
Set Sea & Anchor: 0715 +4Q

5. Pilot and Tug Requirements: Harbor Pilot not required to leave anchorage in harbor area but can be contacted via bridge to bridge channel 16 for assistance by calling St. Maarten Harbor Master.
6. Tides and Currents: The mean range of tide is 1.0 FT. A strong westerly current is constant and varies from 0.5 to 1.0 knots.
7. Weather Predictions: As briefed (Actually clear weather.)
8. Miscellaneous Information:
 - a. Maximum Safe Speed is at CO's discretion.
 - b. Fix interval is 2 minutes within 2NM of nearest danger to navigation.
 - c. Anticipated traffic: as briefed.
 - d. Repeater Errors: CNTL – 0 HELM – 0
PORT – 0 AFT ST – 0.2W
STBD – 1.5E
9. Sunrise: St. Maarten – 0615 +4Q 12 NOV 96
10. Tides (12 NOV 96): 0800 St. Barth: 1.5FT (HIGH)
Currents (08 NOV 96): Not Observable in area.

On the morning of the 12th, the wind was from the east and the ship was tending between 090 and 100. Events move rapidly and smoothly with two exceptions. The first involved the disassembly of the Accom ladder and the second involved difficulty in casting off the CHT barge. Combined, both of these evolutions caused a 33-minute delay in getting underway from anchorage. At 0818, the USS GONZALEZ, with the anchor heaved in, is underway at +20% pitch on both engines.

With two contacts anchored fairly close (~400 yds) on the port side of the ship, the GONZALEZ swings around to her starboard side with both engines ahead 1/3 and a right full rudder intent on steadying on the outbound track course of 263T. In addition to the two contacts off the port side, another cruise liner, the SS NORWAY, is inbound to the anchorage that the GONZALEZ is departing. NORWAY's position is almost directly on the planned outbound track at a range of approximately 1200 YDS. The CHT barge, after casting off from GONZALEZ, turned to the west and then to the south astern of GONZALEZ. Her intention was to head 180 directly to open seas to discharge her tanks overboard. GONZALEZ increases speed to all ahead 1/3 for seven knots. The CO directs the OOD to steady on 180 cutting across the bow of the NORWAY and then, once clear, to turn back to the west to regain the outbound track. The OOD clarifies with the CO his intentions reiterating the intention to affect a starboard-to-starboard passage with NORWAY. NORWAY is contacted via the bridge-to-bridge and her concurrence is obtained for GONZALEZ's intentions. At 0823, as the conning officer orders the ship steady on 180 with an increase of speed to all ahead 2/3 for ten knots, the NAV concurs with the ordered course and reports that course 180 is a good course. This concurrence is made although no DR is placed on the bridge plot. This change in ship's plan is not passed nor explained to CIC.

CIC, confused on the ship's intentions, recommends to the bridge a course of 263 in accordance with the briefed track. No response is received. At 0824, CIC is unable to plot a radar fix due to radar navigation reference points being in the radar "cutouts." Two minutes later, GONZALEZ steadies on course 180. CIC's fix is about 190 YDS northeast of the corresponding bridge fix. No resolution is made on this discrepancy, but CIC reports "our track will come real close to shoal water" based on its first and only DR and recommends course 140.

On the bridge, there is confusion. Upon steadying on course 180T at 0826, the navigation team attempts to locate a buoy marking Proselyte Reef. By the chart and best estimates of ship's position, the navigation team is searching along a bearing of 200T for the buoy, but are unable to visually sight it. GONZALEZ has just crossed the bow of SS NORWAY and the OOD is monitoring the relative position of the CHT barge on the starboard side of the ship in order to effect a turn to the west. Although the NAV is unable to sight the buoy, he recommends to the OOD coming left for the purpose of avoiding "a buoy." Both the CO and the OOD request a bearing to the buoy and it is reported the buoy bears 200T by the quartermaster. Both the CO and OOD are unable to sight the buoy. The OOD inquires why it was necessary to come left if the buoy bears 200T and course 180T is a good course. The NAV replies that the ship is being set to the west and that the buoy marks shoal water. The time is 0827. GONZALEZ is immediately ordered to course 150T with left standard rudder. Ordered speed is still 10 knots and the order is then passed to continue left to course 140T. An increase in speed to 15 knots is ordered but, inexplicably, never rung up. CIC still cannot obtain a fix at 0828 and the fathometer watch reports a rapid decrease in depth. Before the ship is able to steady on course, the crew feels a shudder from the foc'sle of GONZALEZ followed shortly thereafter by a shudder from the stern. GONZALEZ's head is passing to the left through 160T. The CO immediately takes the deck and the conn and orders all stop. GONZALEZ has grounded on Proselyte Reef, ten minutes after the ship has gotten underway.